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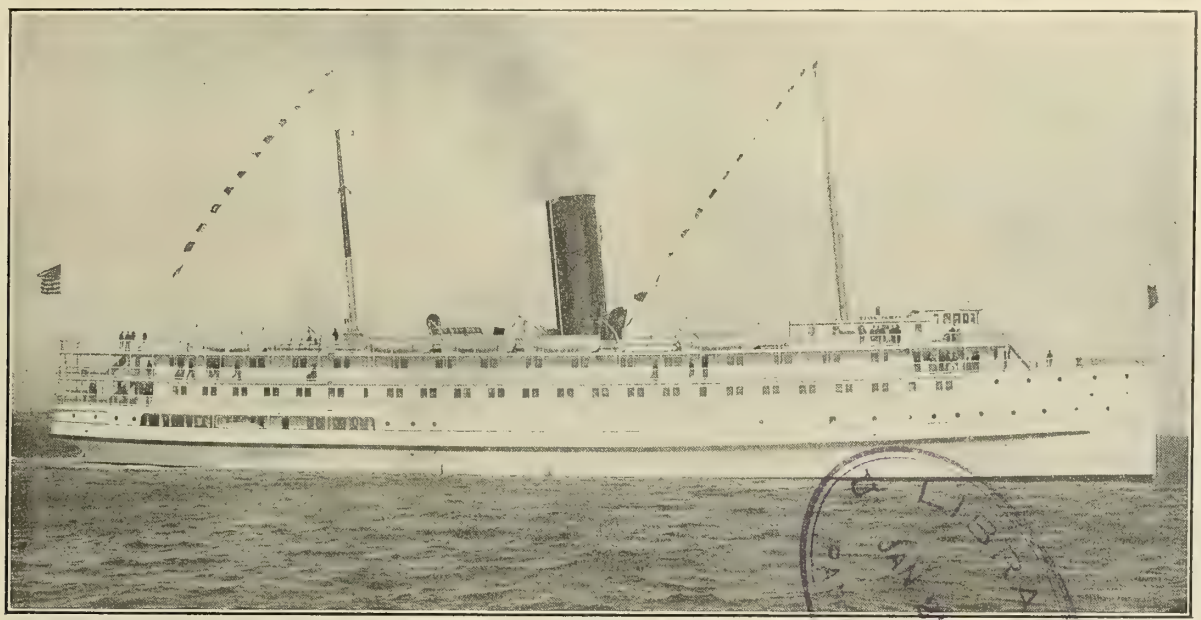
International Marine Engineering

FEBRUARY, 1907.

THE TURBINE STEAMER GOVERNOR COBB.

The first commercial vessel built in the United States, the propulsion of which is to be accomplished by steam turbines, is the *Governor Cobb*, of the Eastern Steamship Company, of Boston. Contract for the construction of this vessel was placed with the W. & A. Fletcher Company, of Hoboken, N. J., and the construction of the hull was sublet to the Delaware River Iron Shipbuilding & Engine Works, of Chester, Pa. The launching occurred April 21, 1906. The turbines and boilers were constructed by the original contractors, and the vessel has now been placed in service.

The ship has a length on the waterline of 290 feet, a length over all of 300 feet, a beam, molded, at waterline of 51 feet, a beam over the guards of 55 feet, a depth of 20 feet 6 inches and a load draft of 14 feet. The tonnage is 2,184. She has a steel hull with a complete double bottom and numerous watertight bulkheads. These latter include steel casings running up through the dome deck, so as to minimize as much as possible all danger from fire from this source.



THE NEW TURBINE PROPELLED PASSENGER STEAMER GOVERNOR COBB.

The turbines are of the Parsons type, as developed by the present builders. They were designed for a total of 5,000 horsepower on three shafts, each of which carries one propeller. The center turbine receives high-pressure steam, while the outer shafts have each in a single casing a low-pressure turbine and an astern turbine. The steam pressure of about 150 pounds per square inch will be supplied from six Scotch boilers fitted for forced draft.

The general method of holding the blades in place on their rotors consists in placing each blade within a properly formed groove and binding it there by means of a tight fitting wedge. The outer ends of the blades on the low-pressure turbines (long blades) are then fastened together by means of wire tape placed in proper grooves, and for further security brazed to the blade. This gives the same general effect, so far as strength is concerned, as the shrouds now used to some extent in other forms of the development of this turbine.

Contrary to general practice, the main shafts do not extend right through the rotors of these turbines. Instead, they end at each end of the rotor, in a heavy cast steel web construction, and the rotor, being made of forged steel, was designed with sufficient longitudinal and lateral strength to maintain its own alinement without aid from the shaft. This has resulted in a considerable saving in weight, and it is believed that the result will be found after extended use to be highly satisfactory. Labyrinth glands have been fitted at each end of the rotor to prevent the escape of steam along the line of the shafting.

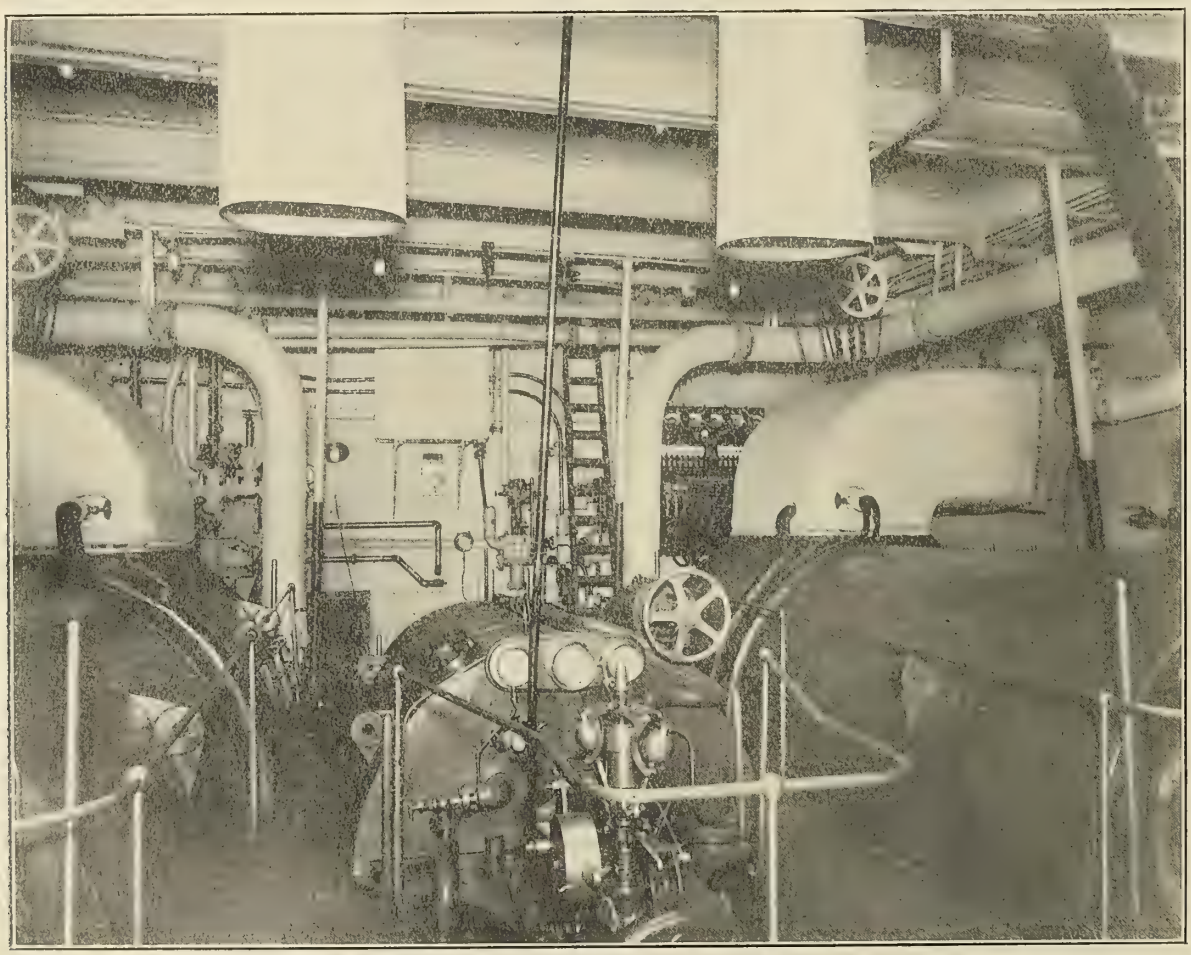
The piping arrangement is such that the first stage of the high-pressure turbine may be by-passed, and steam admitted direct to the second stage. This permits starting the turbine with a larger torque than would otherwise be possible. It is also rendered possible by the piping outfit to turn boiler steam directly into the low-pressure turbines, thus permitting the vessel to be maneuvered to best advantage. It will be noted in this connection that one of the low-pressure turbines could be running forward while the other was running astern, thus making feasible a turning circle of very small diameter. The turbines are governed by means of fly-wheel governors connected by appropriate lever mechanism to the throttle valve, thus limiting the length of time that the valve is open at each impulse of steam.

One of the notable features in the construction of this vessel is to be found in the state rooms on the saloon deck, nearly all of which are of the tandem type. In this arrangement there is a double row of state rooms on each side of the vessel, the outer row having, of course, direct access to light and air from the outside. The inner row is given similar advantages by means of a narrow corridor or passageway extending between two adjacent outer state rooms, and reaching the side of the vessel. Corresponding passageways between two adjacent inside state rooms admit the passengers to the outside rooms. It thus results that each of these state rooms is in the form of an L, and each receives direct light and air.

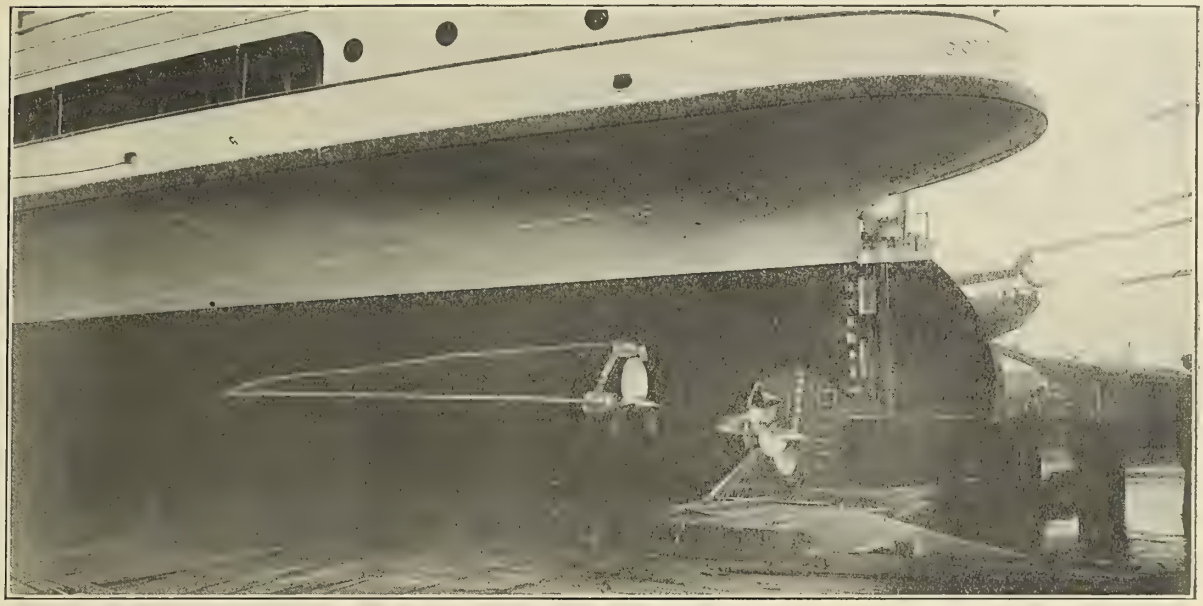
BOW VIEW OF THE GOVERNOR COBB IN A FLOATING DRY-DOCK.

The steamer is fitted with 175 state rooms and can accommodate about two hundred passengers with berths. The dining saloon, which is placed aft on the main deck, is a commodious apartment, the length being 50 feet, the breadth at the forward end 37 feet 4 inches, and at the after end 24 feet 3 inches. Both sides are thoroughly well lighted, nearly the entire length being taken up by windows. The galley is below the forward end of the dining saloon, with which it connects by a staircase.

The keel plate has a width of 45 inches and weighs 31½ pounds per square foot amidships and 25½ pounds at the forward end. The garboard strake and the one next to it are 20-pound plating, decreased to 16 pounds at the ends. The next strake is

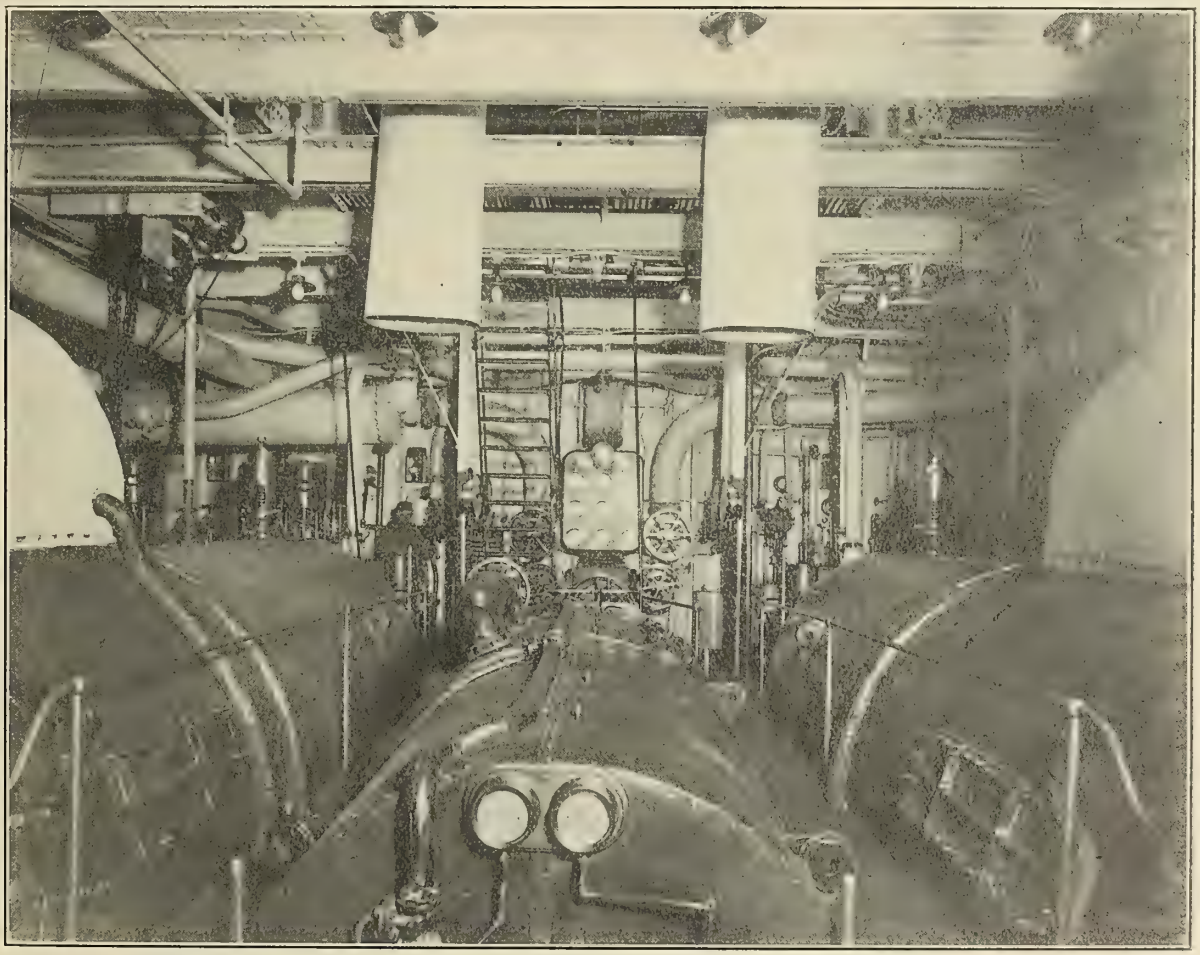


LOOKING AFT IN THE ENGINE ROOM, SHOWING THE THREE TURBINES.
(Photograph, N. L. Stebbins, 1906.)

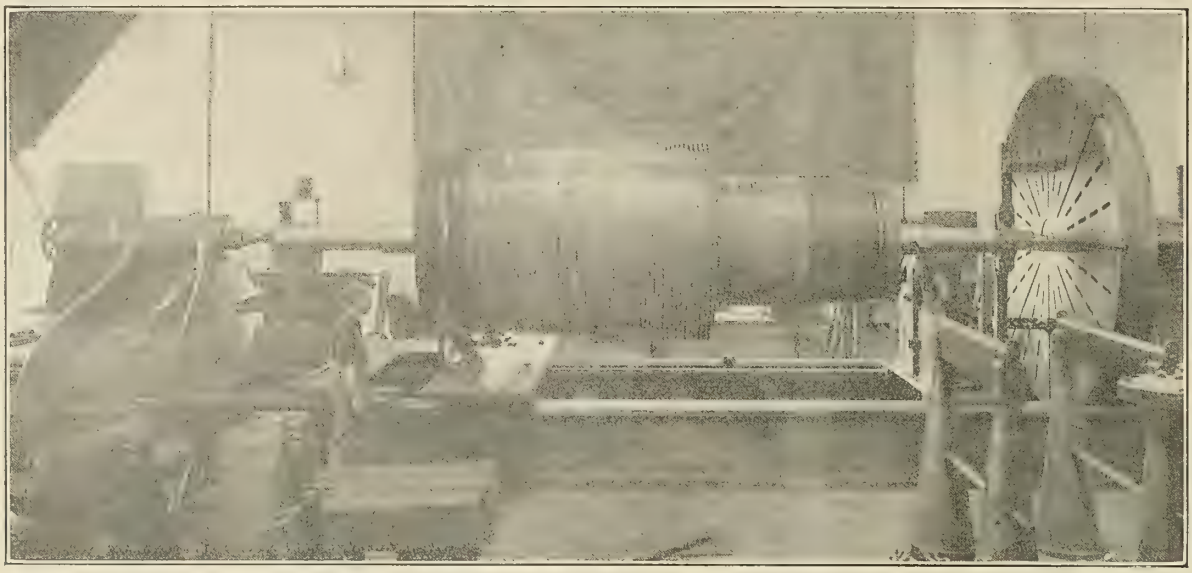


A VIEW OF THE STERN, SHOWING ALL THREE OF THE PROPELLERS.

of 19 and 16-pound plate; the two bilge strakes 21 and 16 pounds; the next 19 and 16 pounds; the next 20 and 16 pounds; and the sheer strake, which has a width of 38 inches, measures 27 pounds amidships and 16 pounds at the ends. The guard, just above the sheer strake, consists of a channel 11 by 3½ by 3½ inches by 30 pounds reinforced by a face plate 12 inches wide and of 40 pounds weight, and secured to the sheer strake by an angle measuring 6 by 4½ inches by 23 pounds. Above this the side plating consists of two strakes, the lower being 15 pounds and the upper 12½ pounds. The lower of these two strakes is connected to the guards by an angle 3½ by 3½ inches by 9.8 pounds and a plate 12 inches wide and 24½ pounds thick.



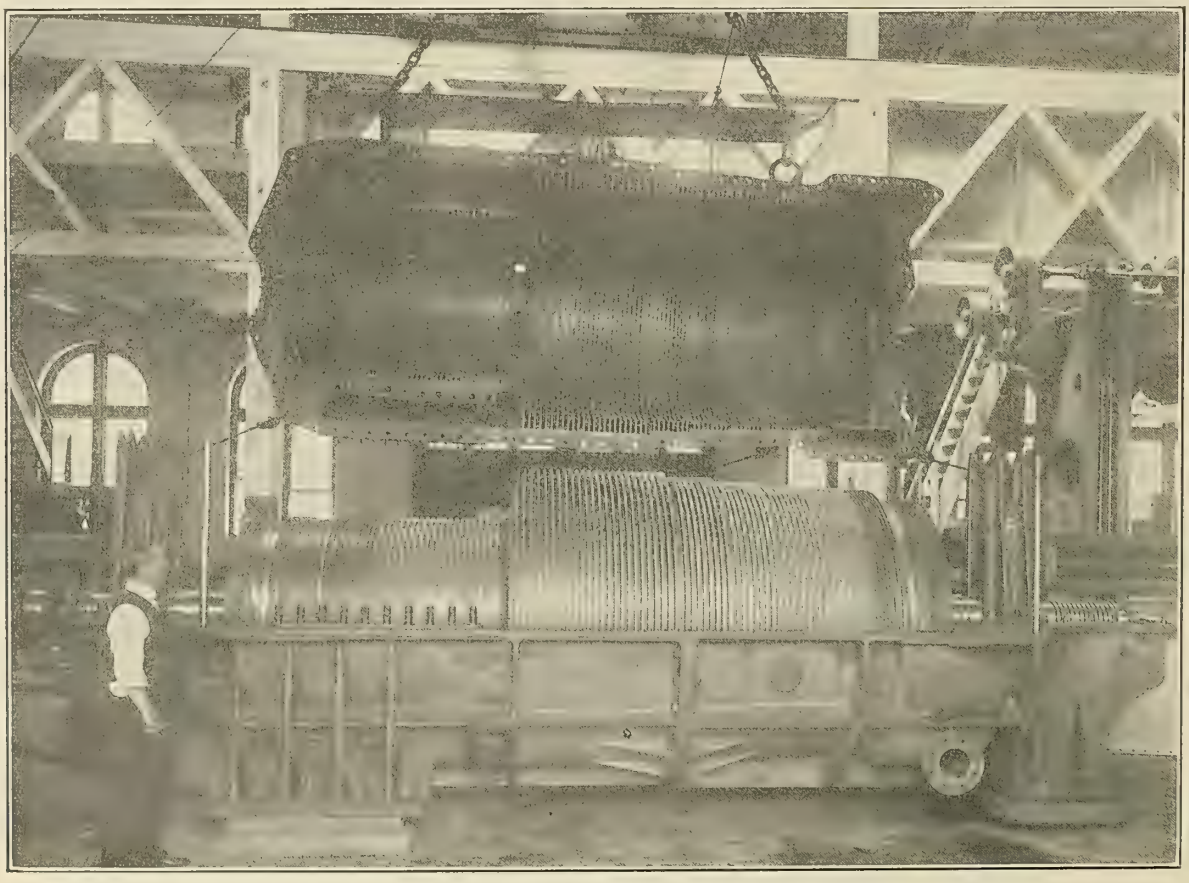
LOOKING FORWARD IN THE ENGINE ROOM, SHOWING OPERATING VALVES.
(Photograph, N. L. Stebbins, 1906.)



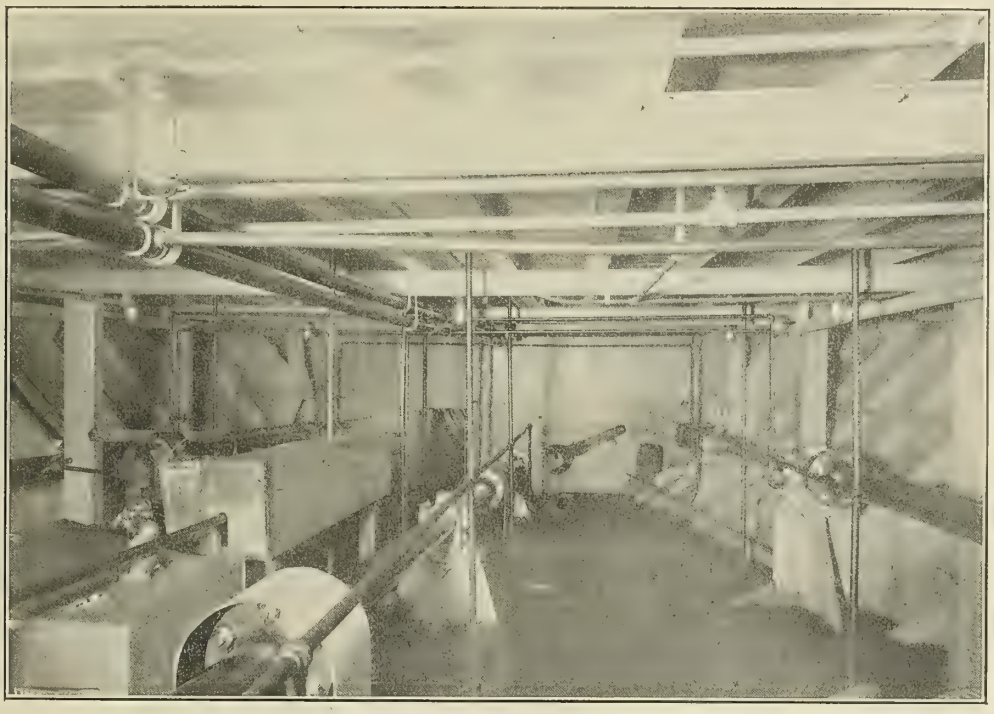
A LOW-PRESSURE ROTOR ON THE LATHE, WITH ASTERN ROTOR ON THE SAME SHAFT.

The lower deck beams are channels 9 inches by 18.2 pounds for 80 feet at the forward end. Elsewhere there are 5-inch by 11.8-pound channels. They have no camber. The spacing in the after hold and for 50 feet at the forward end is 8 feet. Elsewhere it is 16 feet. Upon these beams is a wooden deck of 1-inch material, tongued and grooved, mounted upon fore-and-aft grounds 6 inches high, 2 inches thick and 20 inches apart. The main deck beams are channels 11 by 3½ by 3½ inches by 30 pounds, located on alternate frames, with a slight decrease in thickness of material at the ends of the vessel. Upon these beams is the wooden main deck, while over the engine, boiler and bunker spaces is a complete deck of 10-pound steel. At the ends are tie plates running from 84 inches by 15 pounds to 36 inches by 12½ pounds, with diagonal ties 20 inches by 15 pounds. The saloon deck is mounted upon Z-bar beams measuring 4 by 3 by 3 inches by 11.9 pounds, and located 8 feet apart. Upon this is placed a wood deck 1¼ inches thick.

The frames are angles measuring 4½ by 3 inches by 9.1 pounds and spaced 24 inches apart, being reduced in thickness for one-fifth the length of the vessel at each end. In the after



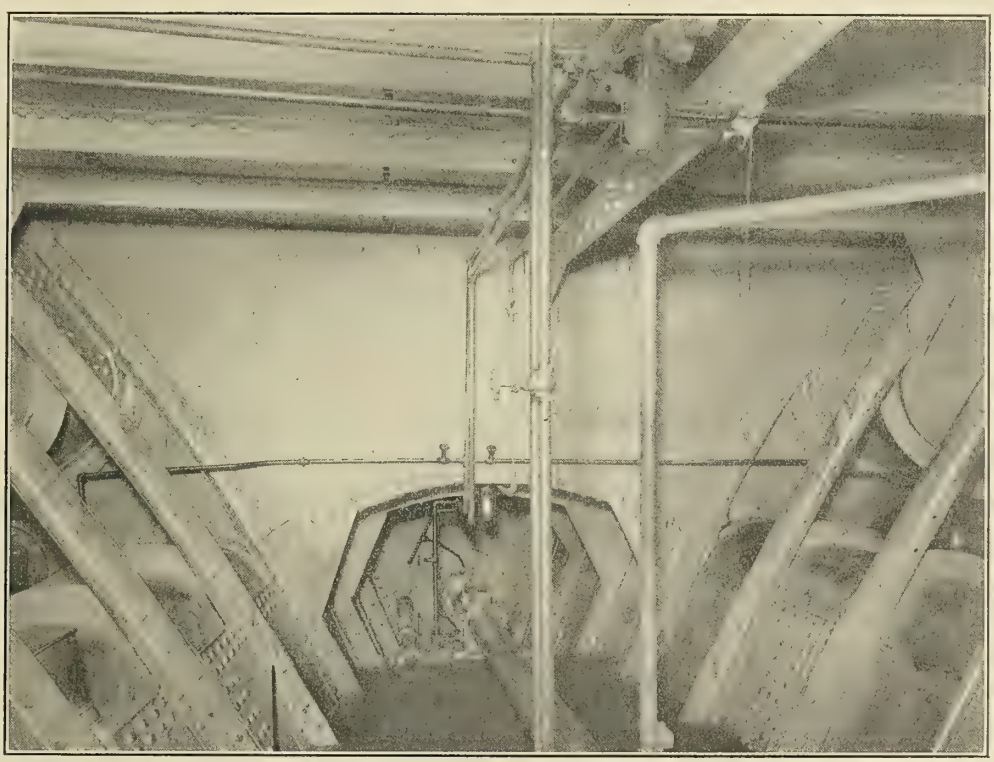
LOW-PRESSURE AND ASTERN ROTOR IN PLACE IN STATOR, UPPER HALF OF WHICH IS SUSPENDED.



THE THREE LINES OF SHAFTING NEAR THE STERN OF THE VESSEL.
Photograph, N. L. Stebbins, 1906.

peak the alternate frames are doubled. Reverse frames are fitted to main deck, and measure 3 by 3 inches by 7.2 pounds, with reduced thickness at the ends. They are doubled in the tank, in engine space and under boiler bearers. The floors are 30 inches deep, and measure 20 pounds amidships and 17 pounds at the ends, being increased to 22½ pounds in the engine and boiler spaces, and deepened to 42 inches in the engine space. The stem is a casting measuring 9 by 2½ inches. Bulkheads measure 13½ pounds for the lower half and 11½ for the upper.

Stanchions to support the main deck beams rest upon the double bottom, and consist of 6-inch by 14½-pound double channels spaced 8 feet apart. At the upper ends the connection is made to the main deck beams by means of double fore and-aft channel runners, 7 inches by 12.6 pounds. These stanchions are 9 feet 3 inches from the center line. The saloon deck is supported by three lines of stanchions, each consisting of tubes measuring 3½ inches in diameter and 5/16-inch thick, and spaced 9 feet apart. The outer rows are 11 feet 5 inches from the center line, and rest upon the tie plates above mentioned. The center line row rests upon a tie measuring 12 inches by 15 pounds. Each row



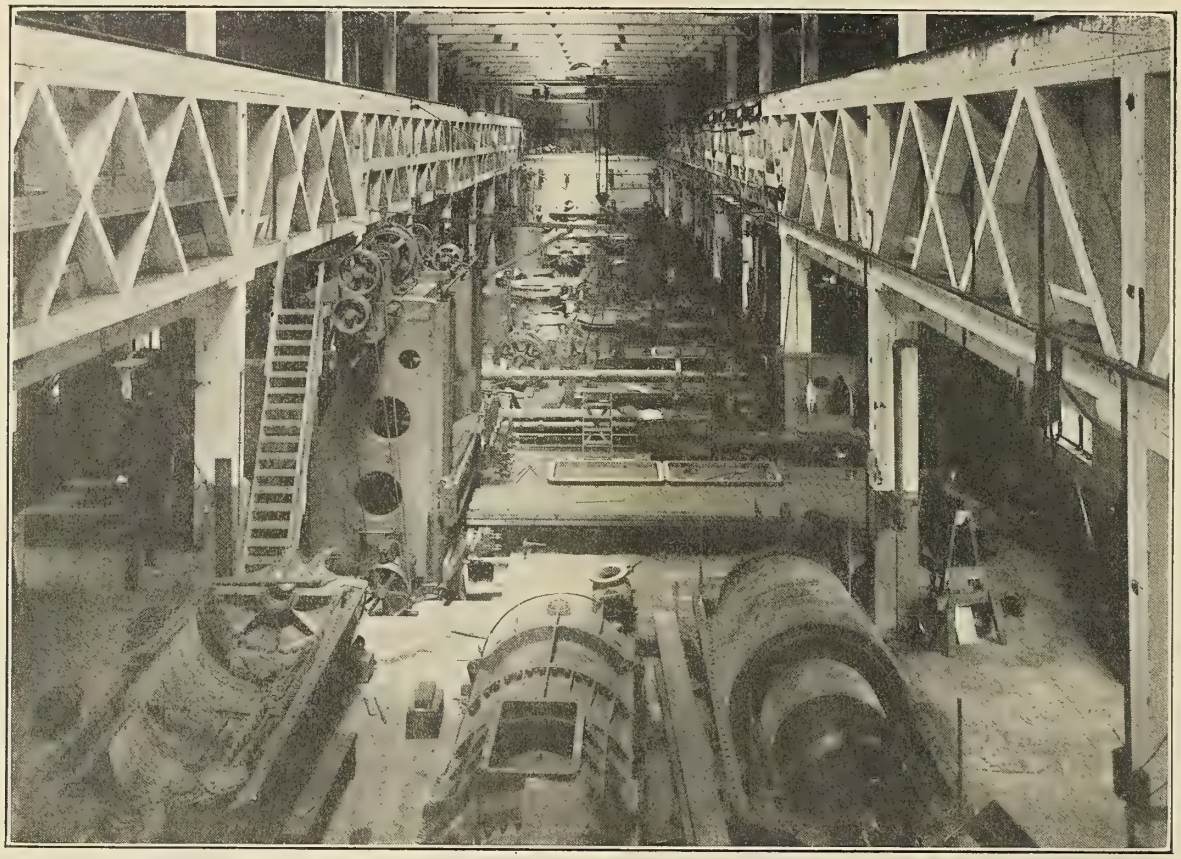
THE AFTER COLLISION BULKHEAD, SHOWING END OF CENTER STERN TUBE.
Photograph, N. L. Stebbins, 1906.

carries a longitudinal I-beam 5 inches by 19 pounds, upon which the saloon deck beams rest.

The double bottom plating measures 13 pounds amidships and 12 pounds at the ends, with a thickness of 17 pounds in the engine and boiler spaces. The center strake is 34 inches wide, and measures 17 to 14 pounds. This plating is supported upon channel girders 12 inches deep and weighing from 22 to 20 pounds per foot. Intercostals are fitted measuring 15 and 14 pounds, while the fore-and-aft angles connecting intercostals to both floor plates and double bottom plating, as well as the angles connecting the floor plates with the double bottom girders, measure 3 by 3 inches by 6.1 to 4.9 pounds. The margin plate measures 15 to 13 pounds, and 17 pounds in the engine and boiler spaces, and is connected to the tank top by an angle 4 by 3½ inches by 9 pounds.

The center longitudinal vertical keelson measures 42 inches by 17 pounds amidships, reduced to 14 pounds at the ends, and carries at the lower edge two angles 3½ by 3½ inches by 9½ pounds, and at the upper edge two angles 3 by 3 inches by 7.2 to 6.1 pounds. The upper edge is connected to the center strake of the tank top. A bilge keelson is fitted at the upper turn of the bilge on each side, and consists of double angles measuring 4½ by 3 inches by 9.1 pounds. A bilge keel is fitted for 115 feet amidships, and consists of a plate of 20-pound steel, 18 inches wide, connected to the shell plating by two angles each 4 by 3½ inches by 9 pounds. The lower deck stringer plate measures 15 pounds amidships and 17 pounds in engine and boiler spaces, and is attached to the frames by angles 3 by 3 inches by 7.2 pounds. The stringer on the main deck is fitted under the deck beams, and measures 60 inches in width amidships by 24½ pounds, being reduced at the ends to 30 inches by 17½ pounds.

Web frames are fitted six frame spaces apart, the webs being 17 inches wide by 15 pounds, and having face angles 4½ by 3 inches by 9.1 pounds, and double angles to connect to side stringer, measuring 3 by 3 inches by 7.2 pounds. Above the main deck web frames of 12½-pound steel are fitted at intervals of 18 feet, and have a minimum width of 15 inches. The face angles are double, and measure 2½ by 2½ inches by 5 pounds.



GENERAL VIEW IN THE FLETCHER SHOP, SHOWING TURBINES UNDER CONSTRUCTION.

COLD STORAGE ON BOARD SHIP.

PART VIII.

BY SYDNEY F. WALKER, M. I. E. E.

TOO MUCH REFRIGERANT IN THE SYSTEM.

It is not often that this arises, though cases have been reported. There is a certain definite quantity of refrigerant that is suitable for each size of plant, each size of compressor, condenser, and so on. The manufacturers in all cases give full particulars of the quantity that should be placed in the system. All manufacturers recommend that a slight excess should be carried, rather than the reverse. With carbonic acid it appears not to be easy to carry a dangerous excess, but with ammonia the trouble does arise, though not frequently. In either case, an excess of the refrigerant, up to 25 percent of the quantity stated by the manufacturer, will do no harm, and will probably help to keep the plant running efficiently and continuously over a longer time, in the presence of leaks, than when only the exact quantity has been placed in the system.

Where, however, a large excess of refrigerant is carried, it means that a large portion of the space available in the condenser is occupied by liquid, a larger space than is necessary, with the result that the gas that is coming over is confined in a smaller space than is intended. A very excessive charge is shown by considerable fluctuation on the pointers of the gages. With regular working, the pointers of the gages go up at each stroke, and then return. With very excessive charge they fluctuate very irregularly. It may be taken that anything which throttles the delivery of the liquid, carbonic acid or ammonia, in its passage to the expansion coils, will increase the condenser pressure, and will raise the temperature at the delivery pipe.

IF THE DELIVERY PIPE BECOMES COLD.

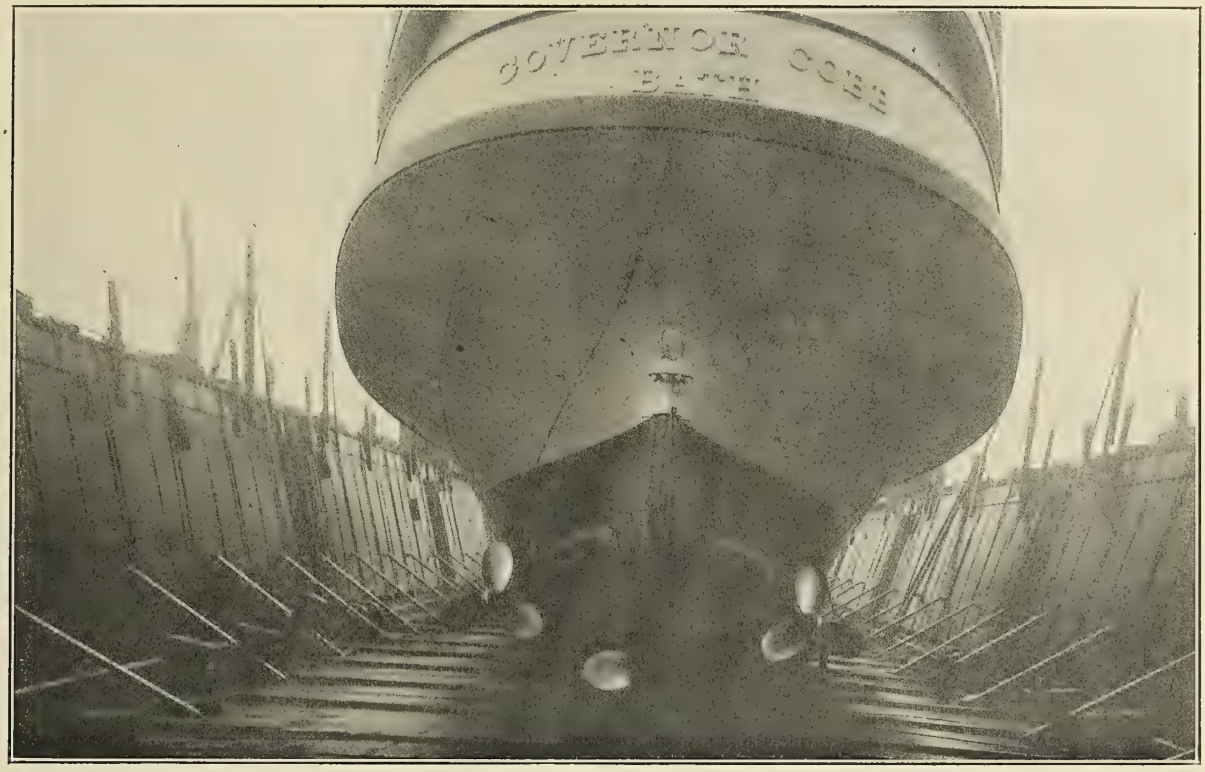
If the delivery pipe from the compressor becomes cooler than it should be, it is a sign that the liquid refrigerant is passing through the regulator valve in larger quantities than it should do, and the pressure at the condenser will be lowered, the heat at the delivery pipe being lowered with it. The remedy is to slightly close the regulator valve, bearing in mind the remark made above as to closing or opening to a very small extent under these circumstances, and as to the effect not being apparent for a few minutes.

WHAT FOLLOWS FROM A HOT COMPRESSOR.

It has been explained that the normal condition of the compressor, when the apparatus is working properly, requires the body of the compressor to be cold, the suction valve and pipe, and sometimes parts of the compressor in the neighborhood of the suction valve, being covered with frost. If the system becomes short of liquid, and if it is not working properly, that is to say, if a sufficient quantity of the liquid refrigerant does not pass into the evaporator coils, and the evaporation does not continue in a minor degree right down to the suction valve, the frost on the suction pipe is lost, and the compressor itself gradually gets hot.

As marine engineers will understand, the natural result of working a piston in a cylinder is the generation of heat, unless means are taken to prevent it. Further, those who have had to do with air compressing machinery know also that the natural result of compressing any gas is the liberation of heat in the gas itself, due to the compression; the heat so liberated being communicated to the compressor. With refrigerating apparatus, any heat in the compressor, as will be explained, is fatal to the effective working of the apparatus, and it is for this reason that a sufficient quantity of the liquid refrigerant is always allowed to pass through the evaporator coils to bring a certain cooling effect right back to the compressor itself, and to keep the compressor cool.

The compressor, though very like a steam cylinder, and still more like an air compressor cylinder, differs from both in one very important particular already dealt with, viz., that on no account must the gas be allowed to leak, since leakage leads to shortage, and the consequences of that have been explained. To meet this requirement, the piston rod of the compressor works in a long gland, designed expressly to prevent the egress of even the smallest quantity of the gas. It consists practically of four parts. There are two sets of packing, carefully cut and arranged in the gland, so that the piston rod will work easily in them, and at the same time they will prevent the egress of gas. Between the two sets of packing there is nearly always a lantern arranged to be filled with a special lubricating oil, the oil itself being maintained in the lantern under pressure. The packing is soaked in the special lubricating oil, and in some forms of apparatus there is an oil chamber outside of the outside packing. It is absolutely necessary that the piston rod shall run perfectly freely, but gastight in the gland, and that it shall always be *absolutely bright.*



STERN VIEW, SHOWING HOW SMALL THE PROPELLERS ARE, AS COMPARED WITH THE HULL THEY PROPEL.

If from any cause the piston rod becomes hot, the immediate consequence is, the packing becomes damaged, and gas commences to escape, this leading to a further damage of the packing, and so on. The same result will follow if the packing is allowed to become deteriorated, if it is not changed periodically when it shows signs of deterioration, and also if it is not screwed up tight in the gland. On the other hand, great care is necessary in fitting the packing into its place, and in screwing the gland up when the packing is in. It will easily be understood by marine engineers that where a very small fraction of an inch out of line will produce sufficient friction to heat the piston rod, and all that follows, great care and some skill are necessary in dealing with this matter.

In addition to this, the piston itself is packed with leathers, and there is also a special lubricating oil always employed to lubricate the piston. For carbonic acid, glycerine of a certain consistency and of a certain purity is recommended by some makers, while others prefer a special oil sold by the Vacuum Oil Company. For ammonia compressors, special oils are again employed, recommended by the different manufacturers. Sulphurous acid compressors, which, so far as the writer is aware, have

not been employed on board ship, have the great advantage that the liquid itself is a lubricant.

Outside of the compressor and connected to the delivery pipe is an oil separator, whose office is similar to that of steam oil separators, but of very much greater importance. Its office is to extract any oil which is carried over with the gas from the compressor. If any oil is carried into the system, as mentioned above, it leads to the same results that have been described in connection with shortage of the refrigerant. It leads to a shortage, by taking the place of a portion of the refrigerant, and sometimes by combining with a portion of the refrigerant. If the compressor is allowed to become hot, as was explained above, the lubricating oil may become vaporized, and a small portion will be carried over with the gas into the condenser, it not being trapped by the separator in the way that the ordinary lubricating oil is. In the ordinary way, when the compressor is working cold, the lubricating oil that is carried over is in a finely divided state in small globules, just as water is carried over from the boiler during the generation of steam; and it is, or should be, got rid of by the oil separator, providing this is properly looked after.

With ammonia compressors, also, there is another and more serious danger, when the compressor becomes hot. At a certain temperature ammonia gas is resolved into its constituents. Ammonia gas, it will be remembered, is a compound whose molecules are formed of one atom of nitrogen gas, and three atoms of hydrogen gas. At a temperature of 900 degrees F. the ammonia gas becomes nitrogen and hydrogen, and these, being incompressible at the temperatures and pressures ruling in the ammonia compression system, remain as permanent gases in the system, giving rise to the same troubles as does air. They get into pockets in the system, being compressed there; they take up space that should be occupied by the ammonia gas; and under certain conditions they may lead to explosion.

GETTING OIL AND FOREIGN BODIES OUT OF THE SYSTEM.

There is a draw-off cock attached to the oil separator in all cases, and it should be drawn off periodically. The frequency of the drawing off will vary with different conditions, but the engineer can hardly go wrong in drawing it off more or less continuously. If it is not drawn off the receptacle into which it falls becomes filled up, and the natural consequence is an increasing quantity of oil carried over into the condenser. If, either from this cause, from the compressor's becoming hot, or from any other cause, oil is found in the system, the first thing to be done is to endeavor to draw it off at the separator by continuous attention. If this fails, it must be drawn out of the system by breaking a joint, first between the condenser and the regulator to drive the oil out of the condenser coils, and afterwards between the evaporator and the compressor to drive the oil out of the evaporator coils.

While the oil is being driven out of the condenser coils, the whole of the charge must be carried over to the evaporator coils, particularly with ammonia, and this is accomplished by opening the regulator valve wide, and closing the suction cock. And when the oil is being driven out of the evaporator coils, the charge must be carried over into the condenser coils, by closing the regulator valve and running the compressor slowly until the gage on the evaporator shows a vacuum.

If the condenser or evaporator coils appear to be in a very bad state inside, as shown by very irregular working, it will be necessary to blow them both through with steam first, and then with air. When a machine is first put into service, after it has been set up, it should always be subjected to a compressed air test, to see that all is in order, all joints tight, and so on; and the same rule applies whenever the system is opened for cleaning. It will be understood that the same trouble mentioned in connection with the deposit on the outside of the condenser coils may also arise from deposit on the inside of both condenser and evaporator coils, from the oil that has been carried over. Also, it is a rule that, before the machine is started, either when first put into service, or when taken apart for cleaning, the cylinder, the valves, and all pipes that can be got at, are thoroughly cleaned out, and all grit and foreign substances removed.

When the condition of the inside of either condenser or evaporator coils becomes bad, as explained, the system is opened up by breaking the joints of the condenser to the delivery pipe, and to the regulator, and the connection of the evaporator coils to the regulator and to the suction pipe. Steam from any convenient source is employed in any convenient way, to blow through each of the coils in succession, until all the foreign matter, oil and so on, has been thoroughly blown out. After this has been done, and when the engineer has thoroughly satisfied himself that no foreign substance remains, the system is connected up again, all joints being made except one at the suction pipe. The compressor is then run slowly, air being drawn into the system, and compressed to 200 pounds per square inch. The broken joint is then remade, and the system is allowed to remain subject to this compressed air pressure for some hours, all joints being carefully examined during the process, and the gages watched.

It should be noted here that the gages will slightly fall after the compressor is stopped, owing to the fact that the air has become heated while the compressor is at work, the pressure thereby rising; while after the compressor is stopped, the whole apparatus radiates heat. The air thence becoming cooler, contracts, and the gage pressures fall. All joints, and all points where leakage will be suspected, should be painted with a lather of soap and water, as explained before, and bubbles looked out for.

To drive the air out of the system, when all joints are good, the methods employed with ammonia, and with carbonic acid, are slightly different. It does not matter if a small quantity of carbonic acid gas is delivered into the atmosphere of the engine room. The small quantity that will be present does no harm, and it forms a ready and certain method of insuring that the air is all got out. With ammonia, however, it is not permissible to allow any of the gas to escape into the atmosphere. Hence the methods are as follows:

With carbonic acid, the joint between the condenser and the regulator is broken, and the air is pumped out of the system through this joint. The system is then partly charged with carbonic acid, and a certain quantity of the gas is blown through the condenser coils into the atmosphere, to waste; the result being that the system is completely freed from air.

With ammonia the method adopted is as follows: The main delivery stop cock is closed, and the small cock on the delivery side, the one that is usually connected to the gage, opened, the gage pipe having been disconnected if necessary, and all other valves and cocks opened, except those leading to the atmosphere. The compressor is then run very slowly, and the air is gradually withdrawn from all parts of the system, and forced out through the small stop cock mentioned, the gages recording the fact by the gradually decreasing pressures. The fact that the air is all exhausted is known by the gages indicating a vacuum, and by the gradually decreasing noise which the air issuing from the small stop cock makes.

As soon as the air has all been driven out, the small stop cock should be closed, and the system at once charged with ammonia in the manner described in the manufacturers' directions. On no account should a vacuum be maintained after the air has all been expelled from the system. Many engineers, when they have had trouble with their plants, with oil and foreign bodies, have made the great mistake, after they have blown through with steam and with air, of pumping a vacuum, and allowing the vacuum to remain for a number of hours. This is wrong, as wrong as it can be, as it almost invariably leads to the entrance of air into the system, and to the troubles attendant thereon. Keep the air pressure on as long as convenient, until you have made all the

joints quite good, but as soon as you have got all the air out, get rid of the vacuum by putting a charge in.

Another point that should perhaps be mentioned, when the compressor is run for the compressed air test, is that, if the delivery pipe and the compressor itself become hot, the compressor should be immediately stopped, the plant allowed to cool down, overhauled, and the whole process gone over again.

Charging with ammonia or carbonic acid is a very simple affair. The gas is contained in strong steel bottles with a regulating valve, to which a flexible or bent metal tube is applied when the gas is to be taken from it, the other end of the tube being connected to the charging valve on the system, which is situated sometimes close to the regulating valve, and sometimes on the other side of the evaporator coils. Only the purest and most perfectly anhydrous carbonic acid or ammonia must be employed. This is one of the most important points in connection with cold storage work. It does not pay to employ cheap refrigerant, if cheapness means impurity. In the working of the system the impurities get separated out. They sometimes appear as permanent gases, sometimes form a deposit on the inside of the condenser or refrigerator pipes, and generally cause trouble.

It is always wise to put the flask of refrigerant upon a scale, when charging the system. This enables the engineer to see exactly how much he has passed. When the connection is made between the flask and the system, the cock on the flask may be opened gradually, the regulator valve of the system being closed, and the gas gradually allowed to pass in, this being shown by two things, the weight of the flask gradually decreasing, and hoar frost commencing to form on the outside of the flask. When about a quarter of the refrigerant contained in the flask has been carried over into the system, the process may be assisted by slightly warming the flask, but great care should be exercised in performing this operation, and it should never be done until the bottle is partially emptied.

It is wiser, in charging the system, to err on the side of a small charge at first, as it is easy to increase the charge if required. After charging, the compressor is run at full speed with the cooling water running over the condenser for a certain time, and then the compressor is stopped, and the system allowed to remain at rest, except that the cooling water continues to pass over the condenser. The object of this is to allow any air remaining in the system to rise to the top of the condenser. This air, in the case of ammonia machines, is carried off from a purge cock place for the purpose at the top of the condenser coils, to which a flexible rubber tube should be attached, the other end of the tube being led into a vessel of water, the end of the tube being under water. When the purge cock is open, the air will come away, and will be seen in bubbles in the water in the vessel, and there will be no smell as long as air is coming. When all the air has been driven out, and ammonia commences to pass, its own particular smell will be noticed, and the purge cock should be immediately closed.

TO TEST AMMONIA FOR PURITY.

Draw off into a stoppered flask with a bent tube, a small quantity of the ammonia to be tested, being careful that none of the snow formed on the tube goes over into the flask. The snow is formed on the tube, in all these cases, by the sudden lowering of the temperature on the outside of the tube, due to the evaporation of the ammonia inside the tube; the lowering of the temperature of the air in the neighborhood of the tube leading to the deposit of moisture, and its immediate freezing. After drawing off the small quantity of ammonia into the flask, allow it to evaporate. If it is pure, the whole of the substance in the flask will disappear. If anything remains in the flask, it consists of impurities, such as water or organic substances. Organic impurities are detected by their smell.

(To be continued.)

EXPLOSIVE ENGINES FOR NAVAL PURPOSES.*

BY ARTHUR T. CHESTER.

The principle upon which an explosive engine operates cannot but be a fascinating study for any one at all interested in machinery, and especially for the marine engineer. To be able to generate power at the point where it is to be applied is in itself a feature warranted to give this engine a place far ahead of any other form of power generator, but added to this is the very important characteristic, that the power is generated only at the instant it can or is desired to be applied.

In the evolution of the steam engine we have gone from the low-pressure, simple expansion, atmospheric exhaust power plants, to the modern high-pressure triple or quadruple expansion, vacuum exhaust systems, increasing thereby the efficiency to a remarkable degree, but this has not been accomplished without a sacrifice. The modern design costs more, requires more intelligent care, necessitates more complication, and involves a far greater expenditure for repairs and up-keep. So marked is this difference that few vessels, except those built especially for speed, are fitted with the most modern and efficient plants. In the navy, however, the questions of weight, space and efficiency are all-important, as upon them depends the armor and armament that can be carried, and the radius of action of the vessel.

We must, therefore, compare the relative merits of the explosive engine with those of the high-pressure modern steam plants, when considering its application to vessels of the navy, and, before going into the present limitations as to the powers generated by this new system, we will take up the different ways in which the explosive engine would add to or detract from the efficiency of a man-of-war. The efficiency of such a vessel can broadly be divided under three headings; *i. e.*, speed, radius of action, and fighting ability.

SPEED.

In the present discussion the speed may be eliminated, as it is assumed that with both systems the horsepower, displacement, and lines of the vessel are the same.

RADIUS OF ACTION.

This depends upon:—

1. Efficiency of the propelling plant.
2. Quantity of fuel carried.
3. Quantity of fuel expended in getting under way, coming to anchor, and while lying prepared to get under way on short notice.

1. Considering coal as the fuel used, an explosive engine connected with a gas producer can (and this has been thoroughly demonstrated) generate one horsepower on from 0.8 to 1 pound of coal per hour. A marine steam engine that can generate a horsepower-hour on from 2 to 2.5 pounds is a very efficient one. Thus we can rightly assume that, with the same amount of coal, an explosive plant will carry a vessel 2½ times as far as a steam plant.

2. A liberal allowance will give 100 pounds of weight of machinery and producers for each horsepower generated by a gas engine, and 150 pounds per horsepower is down to warship figures for steam plants. We therefore have a saving of 50 pounds per horsepower when using gas instead of steam. This saving in weight will allow a corresponding increase in fuel capacity.

3. When a gas engine is connected to a producer, the gas is generated by the suction of the pistons and so is not formed until needed. When the engine is not in operation the fires in the producers simply smoulder, consuming a very few pounds of coal a day. We therefore see that the necessary expenditure of coal in bringing steam up to the working pressure, in letting fires die down when coming to anchor and holding them in readiness, by banking, for service on short notice, is practically

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eliminated in the gas engine plant. This saving must be considered under radius of action, as it allows a vessel to remain longer in active service without recoaling.

FIGHTING ABILITY.

This in turn can be divided into:

1. Number of men available to operate guns and handle ammunition.
2. Weight of armor and armament carried.
3. Ability to get under way quickly and to make a sudden and continuous dash, with as short a notice to the fire-room as possible.
4. Ability to accurately control the speed of the vessel from the bridge.
5. Chances of being disabled by shock or penetration by gun-fire.
6. Visibility at sea.
7. Reliability of the propelling machinery.

Note: The questions of accuracy of fire and quality of armor and armament obviously need not be considered.

1. To operate a producer plant it is necessary only to drop coal in at the top and remove ashes from the bottom. It does not require the continuous and evenly distributed supply of coal, nor does it require the laborious attention by skilled firemen that is necessary with a boiler. This, combined with the fact that at a given speed only two-fifths of the coal consumed in boilers has to be handled, allows us to roughly estimate that a gas plant can be operated by half the men now required in the engineer's force of a man-of-war. Such saving in men permits of a corresponding increase in the complement of the deck or fighting force.

2. The direct saving in weight of machinery and boilers can be used to increase the weight of armor and armament.

3. In time of war all producers can be kept lighted with very slight consumption of coal. This has been demonstrated by producers in stationary plants, where they have remained lighted from eighteen months to two years continuously, and it has been found to be economical, even where the engines were operated only during the day. Under such a condition a vessel is ready to get under way at an instant's notice, while it would be out of the question to do so under steam, even with banked fires. While cruising, it is at present impossible for a vessel to attain her maximum speed without first starting the forced draft system, working up the fires and steam pressure, and going through similar time-consuming operations, while with a gas engine this can be accomplished by simply opening the throttle.

4. To-day the throttle, steam pressure, and fires are closely related, and combine to give the revolutions required. A constant throttle opening by no means guarantees a constant speed. A change of one revolution will often throw a vessel out of position, and to prevent this necessitates constant and intelligent attention to fires, steam pressure, and throttle, and an almost continuous series of orders from the bridge to the fire-room. With a gas engine the throttle and spark control the speed, and as the latter can be set for the approximate speed, it would be an easy matter to put the control of the throttle in the hands of the officer of the deck, on the bridge.

5. Probably the greatest difference in principle between gas and steam engines is the fact that pressure is generated in an outside source in the case of steam engines and generated in the cylinders of a gas engine. With the former an intricate system of boilers and pipes is necessary, and every inch of it must be capable of withstanding the maximum pressure obtained.

The horrible effects from broken pipes or joints or bursting boilers need not be dwelt upon, but, because such an accident may disable the whole propelling power of a vessel, and thus possibly be the cause of losing a battle, the subject becomes one that must be seriously considered. An accident of this kind is not only possible but probable, with lightly armored vessels and torpedo boats, and possible with our battleships while engaging with an efficient enemy.

These dangers are eliminated with the use of gas engines. Absolutely no pressure is used in the producers and connecting pipes, and should one of these become penetrated the engine simply stops, and it will require only the cutting out of the individual producer, or the opening up an auxiliary pipe, to start the engine again. This advantage would be especially noticeable in the case of torpedo boats, where so many accidents are occurring, due to excessive vibrations, light material, and high steam pressure.

6. A vessel is usually first discovered by her smoke, and as there is no smoke to a producer this would be obviated. A torpedo attack can become a failure, due to the glare from one stack, which is a hard matter to prevent when under forced draft.

7. It must be admitted that the explosive engine has not the reputation of being reliable. This reputation, however, is not founded upon an impartial comparison of the steam and explosive plants, and is primarily based upon the troubles encountered by automobilists. It is necessary for a man to obtain an engineer's license to operate a steam engine, while anyone is permitted to run a gas engine. If the same restrictions were applied to both there is little question but that gas engines would show up as well or better than steam. The fact that fishermen and others, depending upon the operation of small boats for their livelihood, have generally adopted the gas engine for propelling power, is a strong argument pointing to the reliability of these engines. Engines built for commercial purposes are more reliable than those manufactured for automobiles, as weight is not such a vital factor, and lower speed and compression can be used; but, without considering this point, it must be remembered that no engine gets more hard usage and less intelligent care than those installed in automobiles. Engine construction has improved so much in the last few years that to-day the greatest troubles an automobilist encounters are with tires, and the remaining ones are due, largely, to chains, differentials, transmission and other points outside of the motor itself.

A gas engine requires no more care and attention than a steam engine, and with the former system all the time, labor, and expense required to keep a modern watertube boiler in condition are eliminated.

GENERAL DISCUSSION.

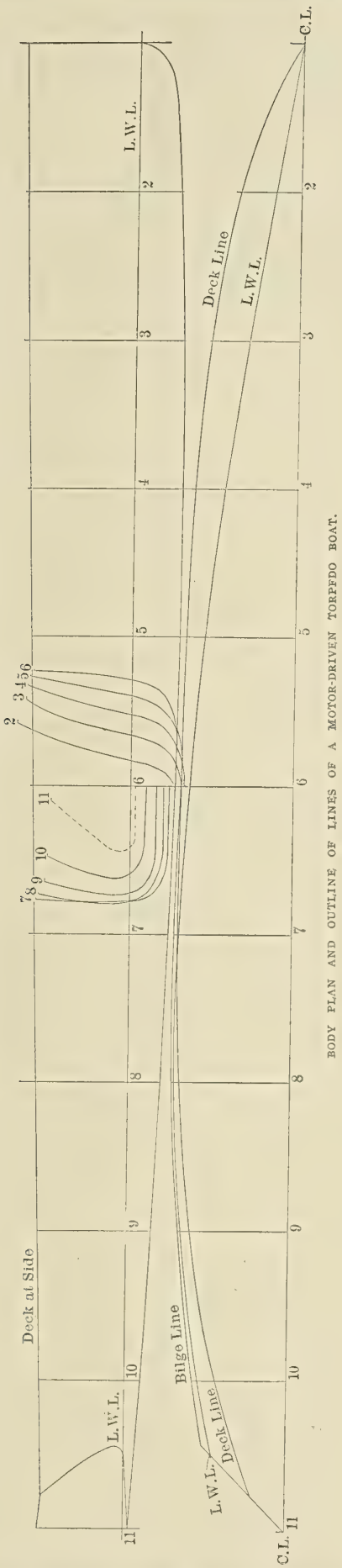
The writer believes absolutely that the coming power generator for all purposes is the gas engine, either reciprocating or turbine. It is probable that the reciprocating engine will hold its place supreme for a long time, not only on account of the mechanical difficulties of obtaining in a turbine the four cycles required to explode gases economically, but also owing to the rapid deterioration of the working parts (if they are at all like the present form of steam turbine), when coming in contact with the necessarily high temperature of exploding gases.

An examination of the gas engines on the market to-day discloses the fact that about 300 horsepower is the largest marine engine manufactured, while stationary engines have been built whose horsepowers range up into the thousands.

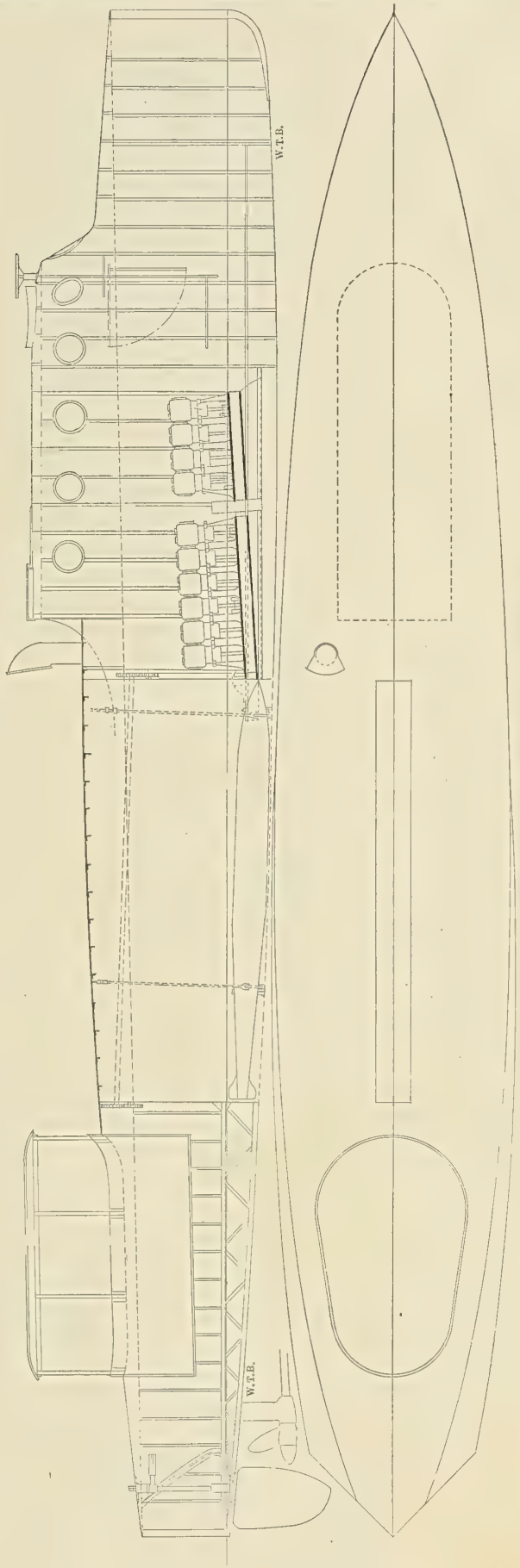
The reasons for this discrepancy are as follows:

With stationary engines weight need not be considered, and so they can be built with large bores, large fly-wheels, and low piston speeds. The low piston speed gives ample time to dispose of the exhaust gases and cool the cylinder between explosions, thus doing away with liability of over-heating. In the case of marine engines, on the other hand, weight forms an important factor. In order to get the required horsepower with a limited bore and stroke, it is necessary to generate a moderately high compression and high piston speed.

If the problem of taking care of the heat can be eliminated, the question of building marine engines of large powers becomes a simple one. Because an engine will work with a small bore and stroke it does not follow that the same design can be used in larger dimensions. For example, in an engine having a



BODY PLAN AND OUTLINE OF LINES OF A MOTOR-DRIVEN TORPEDO BOAT.



INBOARD PROFILE AND DECK PLAN OF A MOTOR-DRIVEN TORPEDO BOAT.

6-inch bore and 6-inch stroke, there is 22/23 of a square inch of radiating surface for each cubic inch of gas. By doubling these dimensions the proportion of radiating surface is reduced to 11/24.

The greatest difficulty is found with the piston, for with the almost universal design this member is not, and cannot readily be, water-cooled. With small dimensions the difference in expansion between the cylinder wall that is cooled, and the piston

that is not, is very slight, and a small allowance for expansion does away with all danger of the piston swelling to the point of sticking or cutting. As soon as the dimensions are increased, however, this difficulty is encountered, and a considerable difference in diameters must be used. A construction of this kind involves the question of leaky pistons, when cool or working below maximum temperature and pressure, and an irregularly expanding piston, owing to the difference in temperature between its upper and lower ends.

The almost universally adopted design of trunk piston for engines of one hundred horsepower or below is without question the best. It does away with piston rod, permits of a true running piston, and also of a very low and compact design. Probably the greatest reason, however, for keeping the trunk piston design is that a double-ended cylinder necessitates water-cooling the piston rod, on account of the high temperature of the exploding gases surrounding it, which would involve unwarranted increase in the complication of the engine.

While this system would be almost a defect in small engines, it is practically a necessity in a larger one, for in order to design the piston to properly fit the bore some means has to be devised for cooling it. By using a double-ended cylinder, the question becomes a comparatively simple one. The rigid connection between piston and hollow piston rod permits of a free circulation of water through the piston rod to the piston, and back through a tube inside the former. The flexible water connection at the cross-head solves the problem of water-cooling the piston and rod. Furthermore, such a design involves a large increase in the horsepower, with only slight increase in weight.

If all surfaces exposed to the high temperature of explosion can be sufficiently cooled to permit of practical working, there is a great advantage in using large instead of small dimensions, for with the reduction of the proportion of area to volume the percentage of loss due to radiation is reduced, and as this source of loss accounts for from 30 to 40 percent of the heat units not turned into actual work, it is a matter of great importance.

While the two-cycle double-ended engine has been advocated as the most advantageous type for large marine producer engines, the writer does not agree with this for the following reasons:

1. The simplicity on account of absence of valves is in a large degree counterbalanced by the necessity of installing a pumping system to force the gases into the cylinders.

2. No two-cycle engines have approached the economical results obtained in a four-cycle engine.

3. This construction requires a piston equal to the length of the stroke, which increases the height of the engine.

4. The difficulties encountered in cooling the cylinder walls and piston are very much increased in the two-cycle engine, as the explosions occur twice as often.

Some have advocated a relatively long stroke, arguing that it permits the gases to expand to a lower pressure, but this reasoning is not based on facts. While it would be true if the same quantity of explosive gases were used, the fact is that the longer the stroke the more gases are drawn into the cylinder. In other words, with a given piston displacement and uniform explosive mixture, the gases will exhaust at the end of the explosive stroke at the same pressure, irrespective of relation of stroke to bore, provided radiation and other conditions are the same. On the other hand, the longer the stroke the greater the piston speed for a given number of revolutions, which is a decided disadvantage.

In summing up the foregoing, it is the writer's belief that the lines upon which a high powered marine engine should be designed are as follows:

1. The engine should be double acting, four-cycle and vertical.

2. Piston, piston rod, valves, cylinder walls, and exhaust pipes should be water-cooled.

3. Some means should be devised to keep the temperature of circulating water within a few degrees of the highest point at which it will effectively cool the engine.

4. The bore and stroke should be about equal.

5. The complication involved in the installation of auxiliary exhaust valves should be omitted, unless found to be absolutely indispensable.

UTILIZATION OF THE GAS ENGINE IN ITS PRESENT STATE OF DEVELOPMENT.

We have discussed the possible application of the gas engine to the requirements of the service some time in the future, after further developments are made, so let us now consider how it can be practically applied today.

All of us remember the Navy Department's efforts toward supplying the *Texas* and *Maine* with sea-going torpedo boats. The attempt became a failure after the boats had been built, not because the theory of carrying torpedo boats on board ship was wrong, but the boats with steam propelling plants were found to be too heavy to be hoisted by a ship's crane, and were barely able to make twelve knots.

The steam launch has been found to be the only practical steam-propelled boat that could be carried on deck, and be capable of standing the rough work required of it. Even this is far from being satisfactory. The engine and boiler necessarily bring the center of gravity high, making the boat unseaworthy, and their weight and the space they occupy leave the boat little carrying capacity. The necessity of reducing the weight to a minimum has required the design of an engine that needs constant skilled attention and frequent repairs, and the final result is a boat capable of making barely seven or eight knots.

The advent of the gas engine has overcome all the difficulties encountered in both these types of boat. It has made the small torpedo boat practical, and permits of a working boat capable of filling all the conditions required of it. To accomplish the former result we can design a boat having a length of, say fifty-five feet, a displacement of from eight to ten tons and a speed ranging between twenty and twenty-two knots. Such a boat would be useful only for torpedo work and picket duty, and others with greater structural strength would have to be carried for rough work.

A recent recommendation of the Torpedo Boat Board to the effect that the speed of all torpedo boats be reduced, has a direct bearing on the subject under consideration, for it permits us to assume that structural strength is more important than excessive speed. This point, taken with the fact that a small boat has very much more chance of coming within striking distance of an enemy before being discovered than a larger one, even though the former has very much less speed, allows us to assume that the speed of our torpedo boat can be reduced to seventeen knots, and still have it very efficient for that service. Such a reduction permits of a structural strength capable of standing up under all the rough work required of a service boat; and broader lines giving more carrying capacity and seaworthiness.

While considering a boat of this character, we cannot escape the important question of how a torpedo can be carried and fired. Obviously the present method of employing a tube on deck for this purpose cannot be used in a boat of this size. Not only would so much weight carried on deck make the boat unseaworthy, but it would be impossible for a man to fire from this position in any kind of a sea. A bow tube is impractical, as even a slight pitching of the boat would alternately bring the tube above and below the water, and a side swash would ruin a torpedo when half way out of the tube. Even if it could be fired in this way without injury, the nose would be in the water before the tail left the tube, and cause it to be deflected from its course.

The English have carried the torpedo in slings that permit of its being dropped over the side. This arrangement either makes it necessary for a man to be on deck to operate it, or requires an open boat, as built by them, that could not live in any kind of a seaway. Another disadvantage of this system is that when a torpedo is dropped horizontally into the water it is impossible for all parts of it to strike the surface simultaneously, and a wave,

when the boat is not exactly head to sea, will deflect that end which strikes first.

This boat must be designed to be closed in fore and aft, so that in a heavy seaway there will be no danger of its filling. Whatever torpedo mechanism is used must therefore be placed within the hull. The fact is hardly disputable that the torpedo must be either entirely in the water or in the air during the act of firing, and as there is no point of discharge from within where we can rely upon the act of firing being started and finished in the air, we must discharge it wholly submerged.

The one place that is always in the water is the midship point of the keel. It is the writer's belief that a narrow well in the center of the boat, having two doors at the bottom, arranged in such a manner that the operation of opening the doors forces the torpedo downward until it is clear of the keel, and arranged so that the torpedo-propelling mechanism is started at the instant the torpedo is released, is the only practical method of discharging a torpedo from a small boat.

Believing that a combination of explosive engines and this method of carrying and discharging a torpedo is the foundation upon which a boat could be designed that would fill all the varied conditions required of it in the navy, the writer interested Mr. D. F. Cox in the idea, and the accompanying design is the result. The time allowed for preparation before going to print has been too short for the working out of details, but the drawings are sufficient to give a general idea of the character of the boat.

The lines show a seaworthy though fast boat. It is fitted with twin screws propelled by two separate engines on each shaft. The arrangement of two engines on each shaft allows us to uncouple the forward ones, or even remove them from the boat under ordinary conditions where excessive speed is not required, and thus the remaining engines can be operated economically and not generate too much power. With the forward engines removed we have increased our room and carrying capacity, and have two well-balanced six-cylinder engines, capable of driving the boat at thirteen or fourteen knots. Another object in providing for a large number of cylinders instead of fewer, with greater dimensions, is to bring the center of gravity as low as possible.

The after cockpit is designed to be self-bailing, having the bottom above the water level, and the top can be lowered down and secured so as to make it watertight when not in use. The helmsman can steer with his body partially above the deck, or with the hatch over him closed, he can steer from within. When required to do so, large liberty parties can be carried on deck in the same way the English use their picket boats. The space on either side of the well is occupied by fuel and air tanks, and storage room.

Probably the greatest opposition to the introduction of explosive engines in the navy has been due to a prejudice against the carrying of gasoline. While the writer believes that with proper arrangement for carrying this oil, and a thorough knowledge of its characteristics, the danger of accidents would be reduced to a very small factor, the practicability of using alcohol has eliminated that small risk.

One of the most attractive features about alcohol is that it has a great affinity for water. A slight leak in the tank or pipes would be dangerous with gasoline, while alcohol would mix with the bilge water and destroy its explosive qualities. The use of alcohol as a fuel for explosive engines requires only a slight increase in compression, and possibly in the admission port opening, and a specially designed carbureter.

One of the most important things to be considered is the selection of an engine for naval purposes. While weight is an important factor it is not the only point to be considered. With a given bore and stroke and a proper design, the only way to decrease the weight per horsepower is to increase the compression and piston speed, or cut down the material used, allowing a small factor of safety.

While such a design is practical for a high speed motor boat, where time enough elapses between runs to keep the engine tuned up to its full power, it is not practical for an engine requiring constant and hard service, as it would receive in the navy.

An engine for that purpose should have a large factor of safety in all its construction, with a comparatively low compression and piston speed. It should have as simple and as accessible a design as possible. Valves should be interchangeable, and arranged so as to be removable without taking off the cylinder head. Cylinders should be cast separate, insuring large main bearings, and a unit construction permitting the removal of one without affecting the others.

Many will differ with the writer in a number of the foregoing statements and opinions, but few of those who have seen the rapid advancement of the explosive engine, and studied its many advantages, can deny that it is only a question of time before steam will be supplanted by the gas engine just as the once universal sail power has been dropped in favor of steam, never again to be considered one of the world's great power generators.

TWO TIMBER DRY-DOCKS AND THEIR PUMPING PLANT.*

BY F. P. PALEN AND G. L. SMITH.

In the discussions of this society the subject of dry-docks has received little attention; and yet it is one which concerns and interests the naval architect and the marine engineer, for, in the present state of the art, the docking of ships is an indispensable part of their upkeep, and we are concerned, not only with the design and construction of ships and their machinery, but also with their maintenance and operation. For these reasons, it would seem that a description of the two timber dry-docks of the Newport News Shipbuilding and Dry-Dock Company at Newport News, Virginia, and their pumping plant, will be of interest; and, while this paper is by no means intended to be an essay on the subject of dry-docks in general, it is hoped that the topic, once broached, may lead to further papers and to discussions which will treat the subject more fully.

The dry-docks referred to are called Numbers 1 and 2, and are of the following general dimensions:

	No. 1.	No. 2.
Length from prow-slip to inside of caisson when in outer lodge	592 feet	831 feet
Width between copings, extreme	131 feet	162 feet
Width at bottom of altars	50 feet	80 feet
Width of entrance, top of inner lodge	93 feet	103 feet
Width of entrance, bottom of inner lodge	52 feet	84 feet
Depth of water over inner sill at mean high water	25 feet	30 feet

Both are Simpson docks, being built almost entirely of timber. No. 1 was constructed by J. E. Simpson & Co. in 1887-89, for the Chesapeake Dry-Dock and Construction Company, which was later absorbed by the Newport News Shipbuilding and Dry-Dock Company. The site of this dry-dock, at the time work was commenced, was covered by the James river to an average depth of ten feet at low water; but this condition was an aid rather than an obstacle to the construction, for it permitted the driving of a coffer-dam around the dry-dock and the dredging of the area within by a water dredge—a cheap and expeditious method of excavation. No. 2 was designed by Mr. W. A. Post, general manager of the company, and was built partly by contract and partly by the shipyard. It was started in 1898 and finished in 1901; and it was, at the time of its completion, the largest dry-dock in the United States.

While the construction of a dry-dock comes properly within the sphere of the civil engineer, it involves questions which are of interest to the members of those branches of engineering which we represent, the problems involved in the construction

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of the body of the dry-dock and of the pumping machinery being closely allied to many of the problems encountered by naval architects and marine engineers in their regular practice.

Except where a graving dock is built in solid rock, or in some other material which will resist the percolation of water, it must be stiffened and sustained against the combination of (1) water and earth pressure from without and the concentrated weights on keel blocks, bilge blocks, docking keel blocks and shores, when emptied of water; and (2) water and earth pressure from without, and water pressure from within, when the dock is filled with water. Figure 1, which represents a transverse section of Dry-Dock No. 2 (the section of No. 1 is almost identical), shows how these conditions have been met; but a brief description of the nature of the soil in which this dry-dock is built will be of service in this connection.

The ground in which Dry-Dock No. 2 was built consists of a substratum of marl of unknown depth, on top of which is a layer of fine, blue sand which formed the original river bottom. Above the blue sand is a fill of yellowish, clayey sand. The marl, which is a compact mixture of clay, sand and shells, resists almost entirely the percolation of water, and is so tenacious that

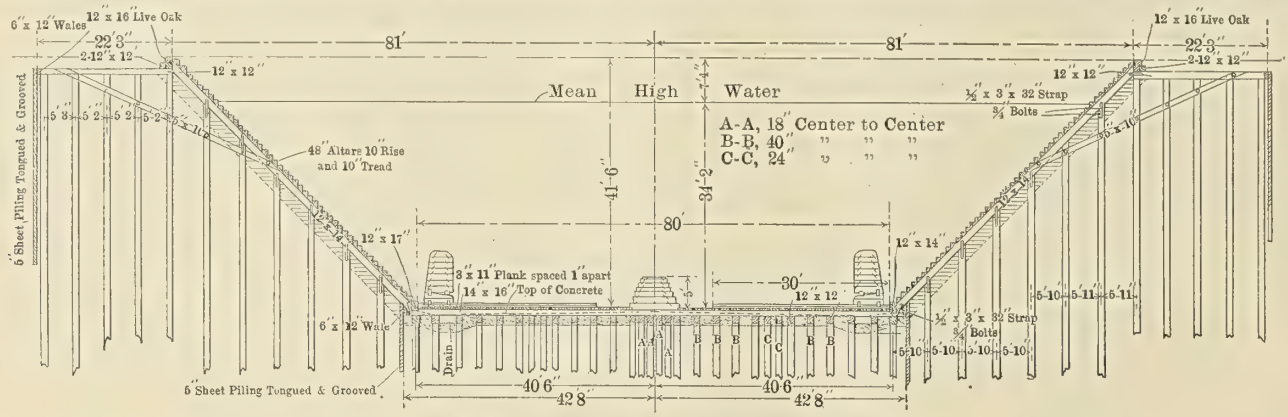


FIG. 1. CROSS SECTION OF DRY-DOCK NUMBER TWO.

it will stand when slightly undercut. If a dry-dock could be dug out of solid marl, piles would be necessary only under keel, docking keel and bilge blocks. The sand above the marl, when slightly moist, has an angle of repose of about 75 degrees; when mixed with a considerable amount of water its angle of repose is 10 degrees or less.

The top of the marl averages about 18 feet below the regular ground grade of the shipyard; so that, if no special precautions be taken, the sides of the dry-dock, at least for a depth of 18 feet, would be subjected to the pressure of a mixture of sand and water, which is considerably in excess of simple hydrostatic pressure. In order to avoid this pressure, and to approximate the condition which would be obtained had the dock been dug in solid marl, a puddle of marl was introduced, as shown, outside of the altars. This device succeeded except where sand became accidentally mixed with the marl puddle. At such places, of which there were only a few, the surface water percolated the puddle, partially dissolved it, and produced a combined water and earth pressure against the backs of the altars. This pressure caused the altars to bulge inwardly, whereupon the joints leaked and the pressure was relieved. How far this proceeded, and what the immediate consequences were, it is difficult to say; but the ultimate result for a considerable length of the dock is, that as the dock is filled, the water level outside of the altar rises, lagging somewhat behind that of the water within the dock, and as the dock is emptied, the water level outside of the altars falls, lagging about two feet behind that of the water inside of the dock. This condition is, after all, a satisfactory one in this place, or in any other, where the ground is firm in character, and the surface drainage is small in quantity or can be restrained; for, where it obtains, the side walls are finally subjected to full hydrostatic pressure on both sides, when the dock is filled with water, and to no hydrostatic pressure when it contains no water. Such conditions could not, of course, be counted on where the ground is boggy or is composed wholly of sand.

Referring to the cross-section, it will be seen that the piling under the keel blocks is closely spaced, and that additional piles are driven under the points where docking keel blocks usually come. Each longitudinal row of piles is capped by a 12 by 12-inch timber, and these caps are surmounted by 14 by 16-inch floor beams, spaced 4 feet on centers, over each transverse row of piles. The side slopes are also piled, the piles being capped by timbers called altar braces, on which are laid the wooden steps or altars. These altars are made by splitting 10 by 16-inch timbers diagonally into two pieces having a trapezoidal section. The altars form steps having 10-inch rise and 10-inch tread, which proportion has been found to be rather inconvenient for climbing. The proportion used in Dry-Dock No. 1 (8-inch rise and 10-inch tread) is a better one. Outside of the coping other piles are driven to serve as braces, and diagonal ties secure the altar braces to these piles and to the altar piles. The bottom of the dock is decked with 3-inch planking, laid with spaces between to allow the water to drain off. At intervals, bilge blocks and slides are fitted, the blocks being operated by chains to the top of the dock in the usual manner.

Below the decking is a layer of concrete, which serves to exclude water and to tie the bottom construction together more securely. In this concrete floor are provided longitudinal drain passages, which carry off part of the water and most of the sediment which comes into the dock from the river. A fall of 4 inches in 100 feet is given these drain passages, which empty into a cross-drain leading into the intake tunnel. On one side of the cross-drain is a rudder pit.

The altars are stopped a considerable distance inside of the entrance, and from the end of the altars to the entrance the walls are of concrete, sheathed with wood. The entrance is built of concrete faced inside with ashlar masonry, Mt. Airy granite being used for this work. There are two lodges or seats for the caisson, the outer one being the one ordinarily used and the inner one being reserved for an emergency. Outside of the outer lodge are wing walls at the sides and an apron at the bottom. The wing walls are granite faced above mean low water, and extend laterally in the form of cutoff walls, which serve to retain the top fill and to prevent the free flow of water around the entrance. The pump-house is common to both dry-docks. At the inshore end of each dock there is a recess called the prow slip, which serves to increase the effective length of the dock and to brace the end.

The caisson, or floating gate, for Dry-Dock No. 2, is shown in section in Fig. 2. It is provided with a flooding valve on either side, and an electrically driven centrifugal pump for discharging water-ballast, and it serves also to carry the six 36-inch culverts and gate valves for flooding the dock. The design of the caisson provides, not only for the stresses due to water pressure

from within and without, but also for those due to the impact of waves and to the blows which the caisson inevitably receives from vessels, both while in place and while moored alongside of the pier.

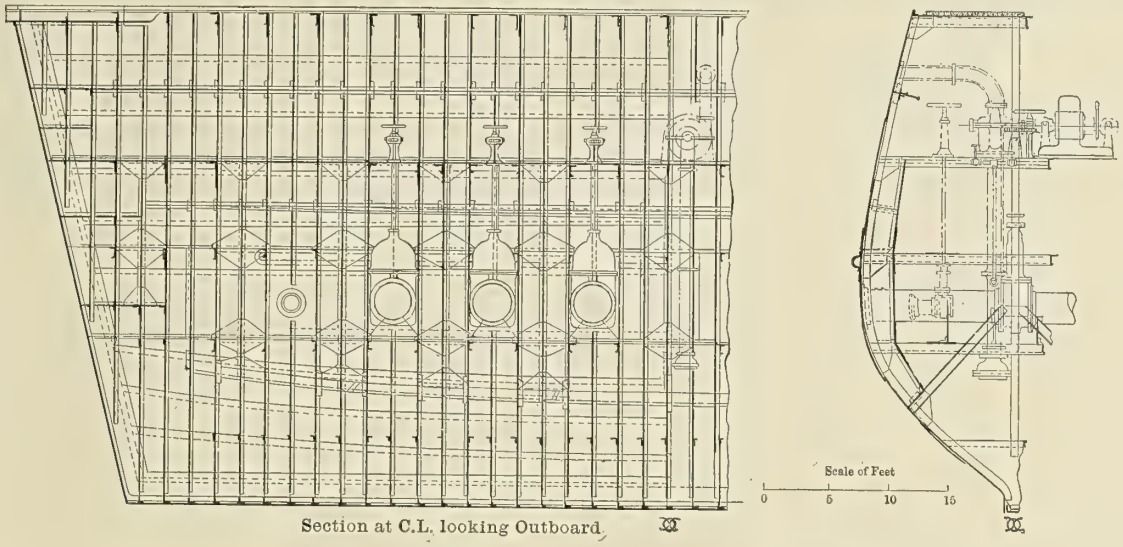
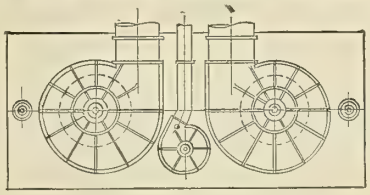


FIG. 2. LONGITUDINAL AND TRANSVERSE SECTIONS OF CAISSON.

A watertight joint between the caisson and the lodge is secured by means of a rubber gasket, which is semi-elliptical in section, with flat wings in line with the major axis of the ellipse. It is made of gasket rubber with heavy canvas insertion, and is secured to the keel by means of flat metal strips held in place by tap rivets. Only one side of the caisson has been used to seat against the lodge, and the gasket on this side has been reduced



in thickness from about 2 inches to about 1¼ inches in the five years of service it has had; but it is still pliable and makes an entirely satisfactory joint. Care is always taken that the caisson is raised high enough from the seat so that the gasket will not rub against the lodge, when the caisson is swung out of place.

The objects to be obtained in the design of such a caisson, outside of the necessary strength to resist water pressure, etc., are (1) the proper proportioning of fixed and water-ballast to permit the sinking of the caisson at highest water level and the raising of the caisson at lowest water level to clear the lodge; and (2) the retention of adequate metacentric height under both of these conditions. In the present case, 160 tons of stone ballast is stowed in a crib in the bottom (to permit inspection and painting of the interior of the hull) and the minimum water-ballast is fixed at 200 tons, which amount gives a metacentric height of 6 inches. The ballast suction pipe is cut off to such a length that the water-ballast shall never be reduced below this amount.

Up to the time that Dry-Dock No. 2 was constructed, the pumping plant for Dry-Dock No. 1 consisted of two centrifugal pumps, operated by two simple steam engines and an independent boiler plant. When the arrangement of pumping machinery for Dry-Dock No. 2 was under discussion, it seemed desirable to undertake the pumping of both docks by one plant, and to abandon the pumping plant for Dry-Dock No. 1. This made advisable the location of a pump-house between the two docks, where the available space was limited. It was also necessary, in order to carry out this idea, to provide satisfactory means for pumping and draining the two docks independently of each other.

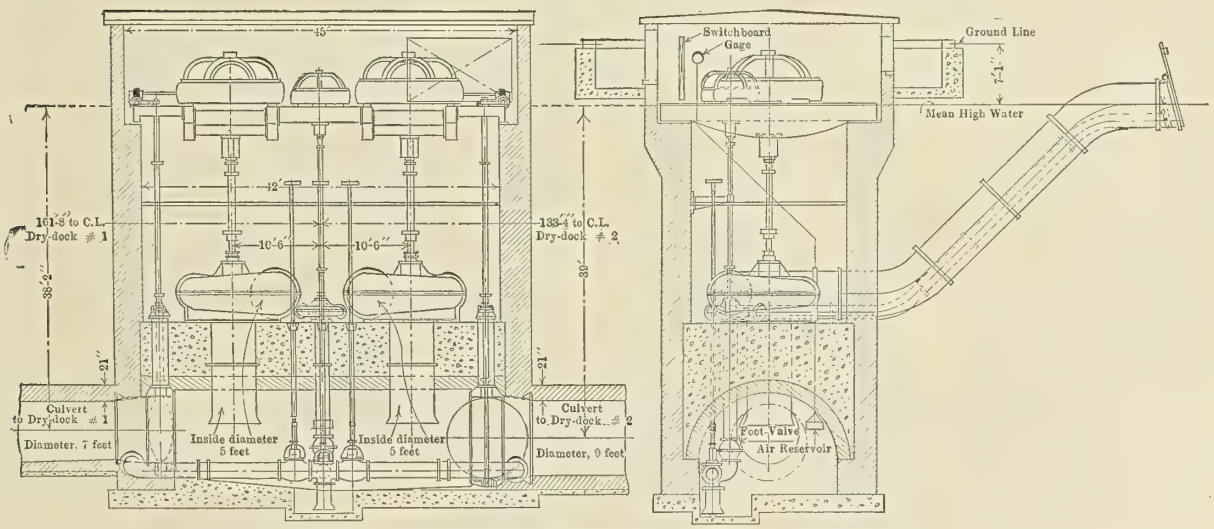


FIG. 3. GENERAL LAYOUT OF PUMPING MACHINERY AND CULVERTS.

The arrangement of pumps and pumping machinery, shown in Fig. 3, was designed by the engineers of the Newport News

Company with a view of utilizing to the best advantage the available ground space, and of arranging the pump-house so that its roof should be low enough to permit the handling of ship's hawsers over it.

The pumping plant consists of two horizontal central suction, centrifugal pumps, direct connected to two General Electric 700-horsepower direct current motors, and one drainage pump of similar design, driven by a 300-horsepower General Electric motor, together with the necessary switchboards, culvert valves and operating gear. This plant has sufficient capacity to discharge 2,200,000 gallons (the amount of water contained in Dry-Dock No. 2 up to mean high water level) against a head varying from 0 feet to 35 feet, in two hours.

The suction and discharge pipes for the main pumps are 60 inches in diameter. The impellers are 8 feet 6 inches in diameter, and are provided with eight convex vanes tapered to 9½ inches width at the tip, the vanes being hooded. Suction and discharge pipe, casings, and impellers are of cast iron. The shafts for driving the pumps are of steel, 9 inches in diameter, and are covered with brass sleeves where they enter the pump-casings. The shaft bearings in the upper halves of the casings are made in halves, in order that they may be removed easily and relined with white metal. The discharge pipes of the main pumps, as well as that from the drainage pump, are provided at the discharge ends with counterbalanced, rubber-seated flap valves. These valves are watertight under all heads, and they

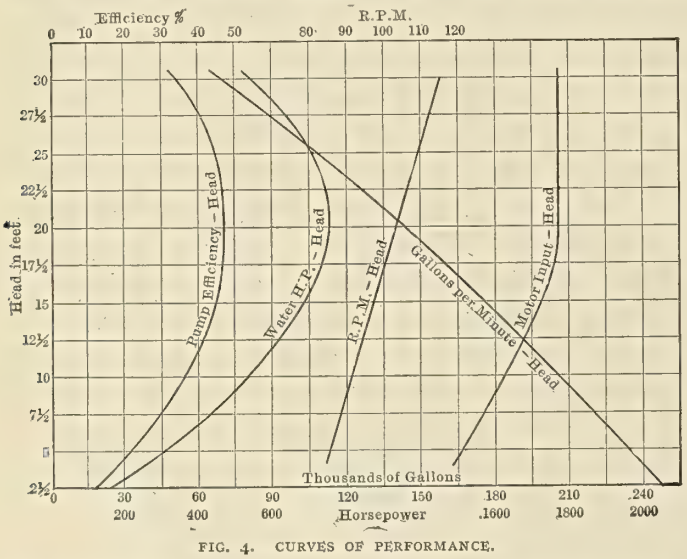


FIG. 4. CURVES OF PERFORMANCE.

have proved so satisfactory that no other valves are needed in the discharge piping.

The drainage pump has a 19-inch suction and an 18-inch discharge pipe. The impeller is 4 feet in diameter and the valves are 3 inches wide at the tips. Casing and impeller are of cast iron. This pump has a 4-inch connection for priming, a foot valve being fitted at the bottom of the central suction pipe to hold the priming.

The impellers are direct connected by vertical shafts to the motor armatures, the motors being directly over the pumps, as shown in Fig. 3. This arrangement permits the location of the pumps at the bottom of the pit, thus making a short lift on the suction side, and places the motors near the surface of the ground, where they may be kept dry; it requires a minimum amount of floor space, and a pump pit only large enough to accommodate the pumps themselves.

The weight of each impeller, shaft and armature is carried by a solid collar thrust bearing, bolted to the bottom of the cast iron box girders which support the motors. The thrust bearings are lined with white metal and are made in halves, in order that they may be overhauled easily. They are surrounded by water jackets and are provided with oil pockets, from which oil holes lead to the bottom and tip of each thrust collar, centrifugal force causing the oil to run out of the holes at the tip and into the holes at the bottom. There is thus secured a continuous circulation of oil around the collars. On top of the girders and immediately beneath the armatures are located cast iron steady bearings for the main shafts.

The power for operating the pumps is supplied from the main power-house. For this purpose there are available two 600-kilowatt generators operated at 250 volts, these generators being connected to the pump motors by a modification of the three-wire system, so that the motors are supplied with current at 500 volts. In order to attain the miximum efficiency, it is desirable that the pumps should be speeded up as the head of water increases. This is done by controlling the fields of the motors through a variable resistance, the speed of the motors being increased from 80 to 120 revolutions per minute during the pumping period.

The results of a test of the pumping plant are shown by the curves on Fig. 4. It will be seen from these curves that the revolutions were increased at a uniform rate during the test, that the gallons per minute decreased at almost a uniform rate, and that the water horsepower and the efficiency of the pumps reached a maximum when the pumps were discharging each about 70,000 gallons per minute, against a head of about 21 feet.

There is fitted in the pump house a gage showing the head of water against which the pumps are working and the corresponding speed at which they should run. This gage, together with tachometers on the pump shafts, serve as a guide to the engineer in regulating the speeds of the pumps.

The arrangement of intake culverts and the construction of the pump house are shown in Fig. 3. The pump house walls are of brick, and no foundation other than the solid marl is provided. The intake culverts for Dry-Docks Nos. 1 and 2 are 7 feet and 9 feet in diameter, respectively. The culverts lead into a well beneath the pump house, which is arched over with brick. Above the arch is a concrete fill, on top of which the pumps are located, and through which the suction pipes pass. The bottom of the well slopes towards the center, at which point there is a sump for the drainage-pump suction.

Where the 7-foot and 9-foot culverts join the pump pit, there are located valves for closing the culverts. The ordinary butterfly valve was used for this purpose, this type of valve being cheaper and simpler than anything else that could be devised. These valves are made of cast iron, in two wedge-shaped halves bolted together around the shaft. The valve disks are oval in form, and when closed they lie diagonally across the culvert, the beveled edge making a joint with the turned cast iron casing, which forms part of the culvert wall. The weight of each of these valves is carried by a collar on the vertical shaft, which rests on a brass bearing at the top of the shaft casing leading through the concrete over the pump pit. The valves are operated by a 6-horsepower motor connected by shafting and worm gearing to either of the valves.

During the five years these valves have been in service, they have remained at all times practically watertight, and have never required any repairs. They have not rusted, owing to the accumulation of a thin coating of marine slime, which further assists in making a joint between valves and seats. The leakage through the larger of the valves, when subjected to a head of 40 feet, amounted to no more than what would flow through a ¼-inch pipe under the same head, this leakage being about equally distributed between the lower pintle and the side of the valve.

The independent drainage of the two docks is accomplished by means of branch pipes leading from the suction of the drainage pump, under the butterfly valves and into the culverts. Each of these branch pipes and the central suction pipe is provided with a stop valve, so that either dock or the pump pit may be drained independently.

Under ordinary conditions (when keel blocks and bilge blocks do not have to be reset), the various operations involved in docking a ship in Dry-Dock No. 2 require the following length of time:

Hauling vessel in and placing	20 to 40 minutes
Replacing caisson	10 minutes
Sinking caisson	10 minutes
Pumping out dock	2 hours 10 minutes
Flooding dock	1 hour 30 minutes
Pumping out caisson	20 minutes
Removing caisson	10 minutes
Hauling vessel out	10 to 20 minutes
Total	5 to 5½ hours

The force required for the operation of both dry-docks consists of one dockmaster, one assistant dockmaster, one engineer, one assistant engineer and fourteen laborers.

An Electric Graving Dock Pumping Plant at Hong Kong.

An interesting electrical equipment has recently been installed at Hong Kong for the new graving dock at Quarry Bay, for pumping purposes, including a pair of motor driven twin parallel pumps of the horizontal type, a vertical electric centrifugal pump and an electric air pump for exhausting the air from the two main pumps. There is also provided a pair of electrically operated sluice valves, one of which is shown in Fig. 1, located in the discharge pipes from the main pumps which empty the dock. It will be noted that these 51-inch electrically driven sluice valves are constructed in two parts, of cast iron bolted together, gun metal being used for the facings of the seatings. A bronze spindle working in a gun metal nut raises the sluice door, the small electric motor rotating the spindle by means of a worm gearing at the head being mounted on the upper casting of the valve, on a bracket provided for the purpose. An instrument is fitted for indicating the current, and another for showing the position of the door, and an automatic circuit breaker is so arranged as to cut out the motor when the door has been fully opened or closed.

Figure 2 shows the design and construction of the discharge culvert for this dock, provided with a score of hinged doors or flaps of wood with leather joints. This cast iron multiple flap valve is 11 feet by 9 feet, and closes the mouth of the discharge culvert from the dock leading into the sea below the high water level.

The apparatus was all constructed in England, at the Queen's Engineering Works, at Bedford, by W. H. Allen, Son & Co., Ltd., and is said to be one of the largest electrically driven dock

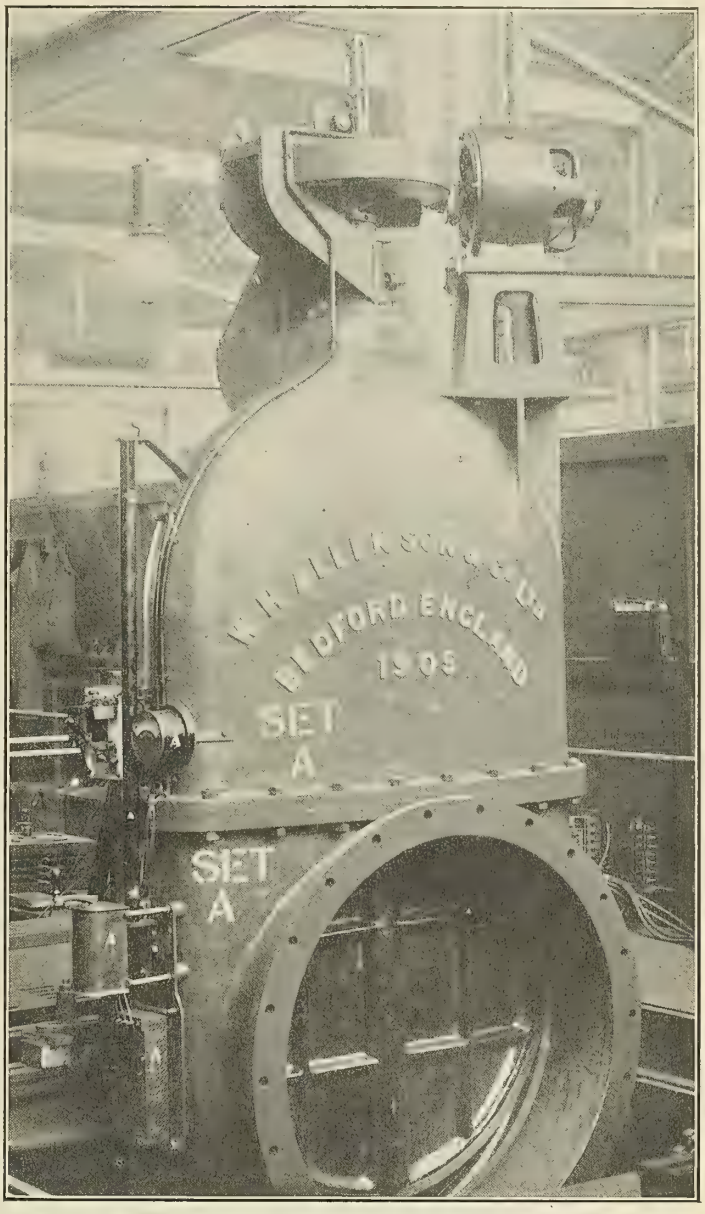


FIG. 1. ELECTRICALLY OPERATED GRAVING DOCK SLUICE VALVE.

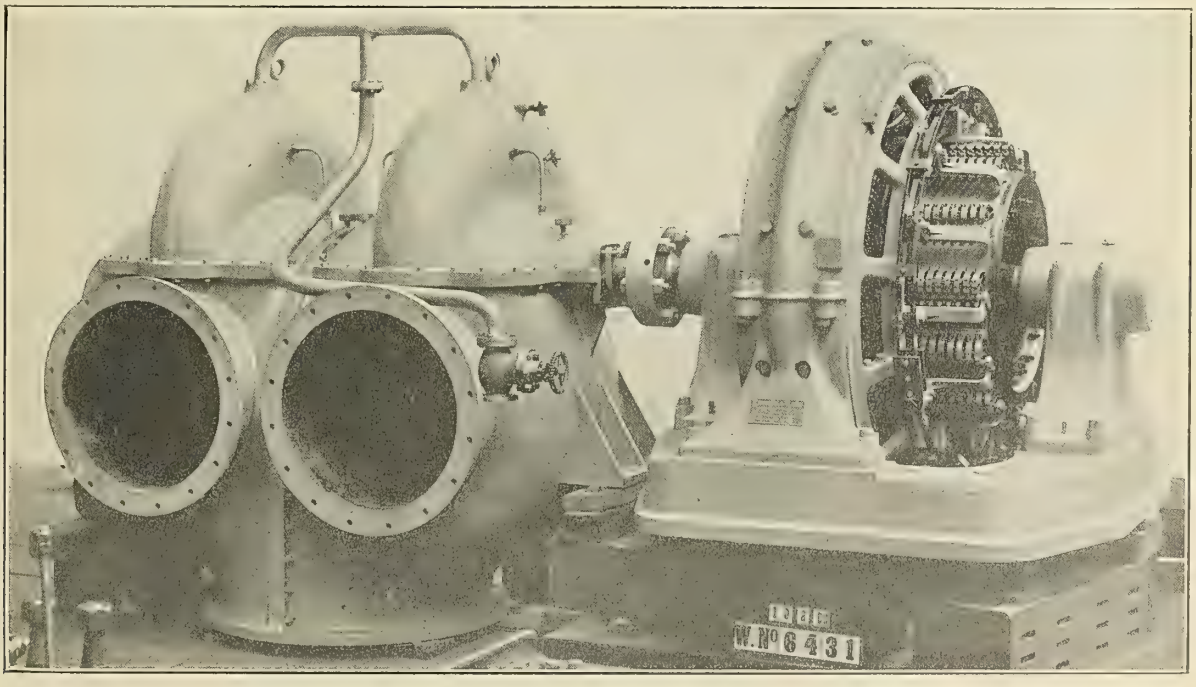


FIG. 3. MOTOR-DRIVEN TWIN PARALLEL PUMPS OF THE HONG KONG GRAVING DOCK, AT QUARRY BAY.

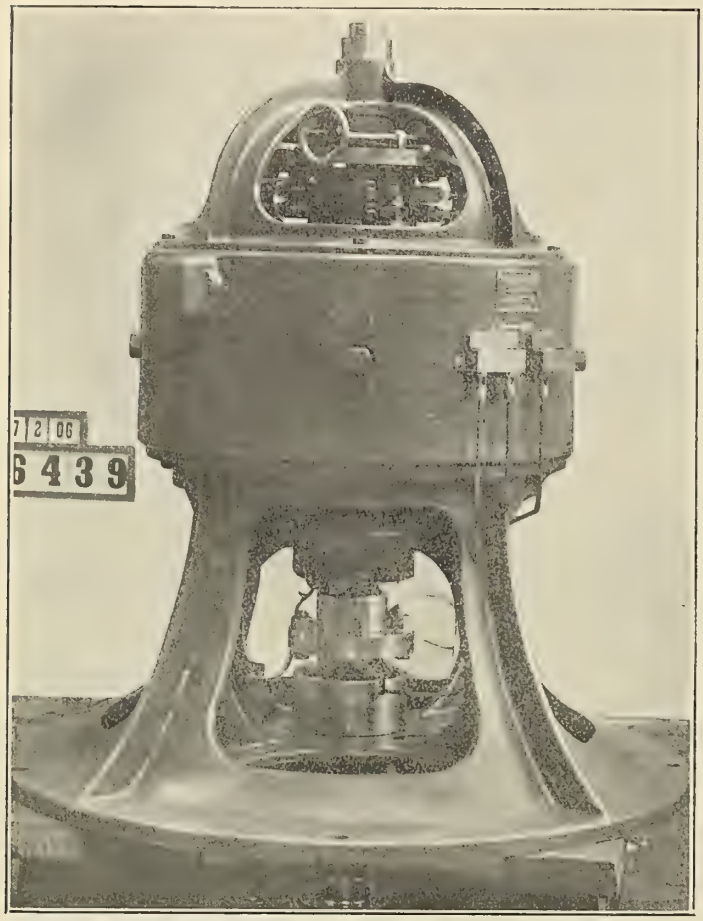


FIG. 4. MOTOR FOR DRAINAGE PUMP, HONG KONG GRAVING DOCK.

plants in existence. The main motor driven pumps are shown in Fig. 3, and have a capacity of over 77,000 tons of water (2,800,000 cubic feet) in less than three hours, emptying the dock in that time. These twin parallel centrifugal pumps are 4 feet 6 inches in diameter, with two cast iron impellers for each on the same shaft. The impellers are 43 inches in diameter, and the suction is so designed that the water divides into three streams, two of which enter the impeller on the two faces which are away from each other, while the center stream enters the two impellers on the two faces which are towards each other. As seen in the illustration, a Y-shaped construction has been provided for uniting the two separate discharges. The electric motor is of the direct current multipolar type, developing 600 horsepower, and operating at a speed of about 275 revolutions per minute, the pressure being 250 volts.

Figure 4 shows the English vertical electric motor employed for the drainage pump at the Quarry Bay graving dock, this electric motor being connected to a centrifugal pump for drainage purposes, provided with a two-foot impeller and operating at a speed varying above and below 600 revolutions per minute. This pump is utilized for keeping the dock dry when it has been pumped out, and for handling whatever leakage may take place. The vertical motor is of the semi-inclosed type, capable of developing 40 horsepower, and the rotating parts are carried on thrust ball bearings of the Hoffman design.

In order to exhaust the air from the two twin parallel centrifugal pumps, a motor driven two-throw air pump has been installed, of the type shown in Fig. 5. This pump is of the Allen-Edwards type, and has a stroke of 7 inches, the cylinders measuring 10 inches in diameter. As seen in the view the motor is mounted on a common base with the two-throw pump, driving the latter through high speed silent chain of the Hans-Renolds type. The motor has a capacity of 6 horsepower, and is of the four-pole direct current type, operating on a 250-volt circuit.

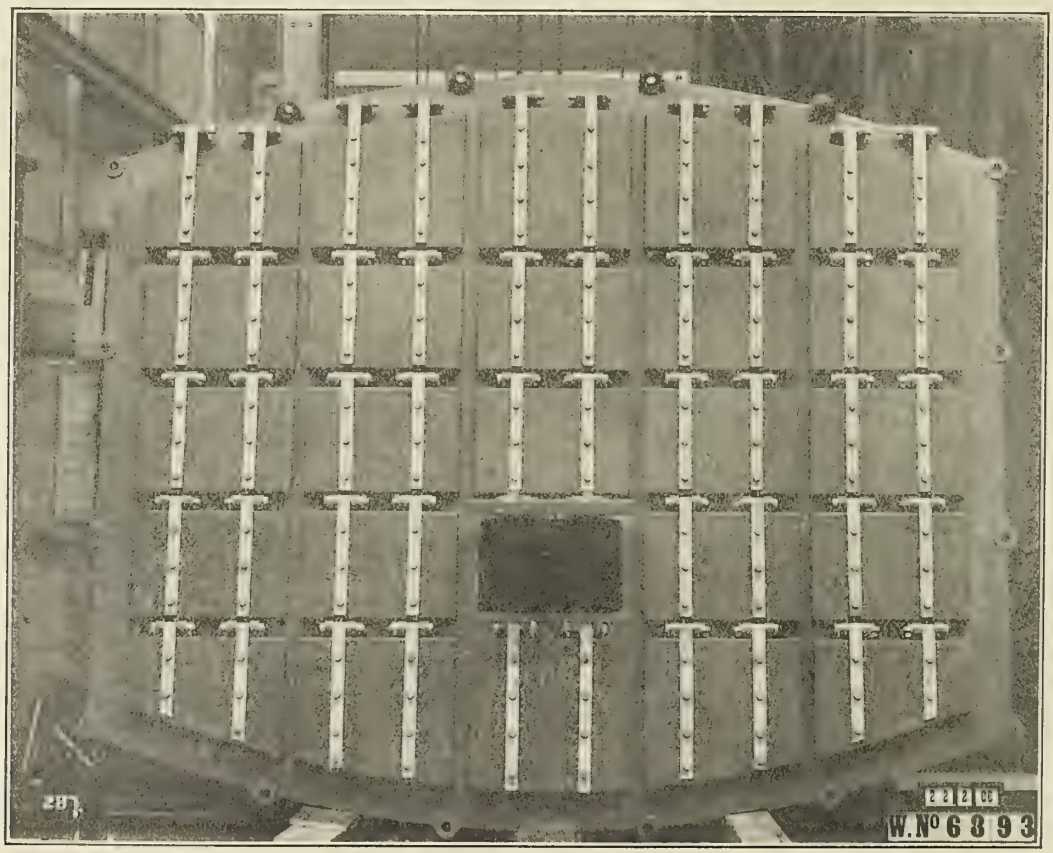


FIG. 5. DISCHARGE CULVERT OF GRAVING DOCK AT QUARRY BAY, HONG KONG.

UNITED STATES REVENUE CUTTER NO. 16.

A new single screw steel cutter for life-saving service on the North Pacific coast of the United States has been designed in the Treasury Department, and we are enabled to present drawings and particulars of this vessel, bids for the construction of which are to be opened February 7, 1907.

The principal dimensions are:

Length over all	152 feet	
Length between perpendiculars	139 feet 6	inches
Beam, molded	29 feet 0	inches
Depth at side, amidships	17 feet 6	inches
Mean draft above base line	12 feet 4½	inches
Corresponding displacement	794.5 tons	
Coal supply	125 tons	
Fresh water supply	11,000 gallons	

The displacement at a mean draft of 13 feet 4½ inches is 884.4 tons. The added displacement for each extra inch of immersion at the waterline is 7.5 tons.

THE HULL.

The keel, which is of the vertical bar type, is of hammered iron, 6½ inches deep and 1¾ inches thick. The stem, of the same material, measures 7 by 1⅞ inches. The propeller and rudder posts, with the portion forming the counter and shoe, will be in one forging of hammered iron, with an eye for the stern tube worked on the propeller post. The hub on each side of the eye will be 3 inches thick, the post itself being 7 inches wide and 4 inches thick. The rudder post measures 6½ by 3 inches, and is provided with stops to prevent the rudder from swinging through an arc of more than 40 degrees on each side of the center line. The rudder frame is of hammered iron forged in one piece, and is covered with 12½-pound plates calked watertight, with sugar pine filled in solid. The minimum diameter of the rudder head is 5½ inches. The pintles have a diameter of 2¾ inches.

The transverse frames are spaced 24 inches between centers, and for one-half the length amidships measure 3½ by 3 inches by 7.9 pounds, reduced at the ends to 6.6 pounds. They are fitted in one piece from keel to head at under side of main deck stringer plates, except in double bottom, where they are cut in wake of fore-and-aft coal bunker bulkheads. There will be three belt frames in the boiler space, each 12 inches deep, and formed by 15-pound plates with double 3 by 2½-inch by 4.9-pound angles on inner edge. The reverse frames for one-half length amidships are the same size as the frames. At the ends they measure 3 by 3 inches by 4.9 pounds. Forward and aft of engine and boiler spaces they are single, and will extend alternately to main deck stringer plate, and one foot above upper bilge stringer. In the engine space they are doubled. The floor plates measure in general 17 inches deep under the throat and 15 pounds thick. The transom floors will be 25 inches deep, while the floors under the engine will measure 20 pounds. The floors in boiler room are 33 inches deep in the throat, and of 18-pound steel, lightened by holes. The high floors forming the engine foundation will be pierced with lightening holes. Limber holes, 4 inches in diameter, will be cut in all floors, except those of transverse watertight bulkheads.

A middle line vertical keelson, 12 inches deep and of 15-pound plate, is fitted, being increased in depth at connections to transverse bulkheads. At top and bottom of this keelson are double angles, 3½ by 3½ inches by 8½ pounds. A rider plate of 15-pound steel 7½ inches wide, is fitted to the top. A horizontal

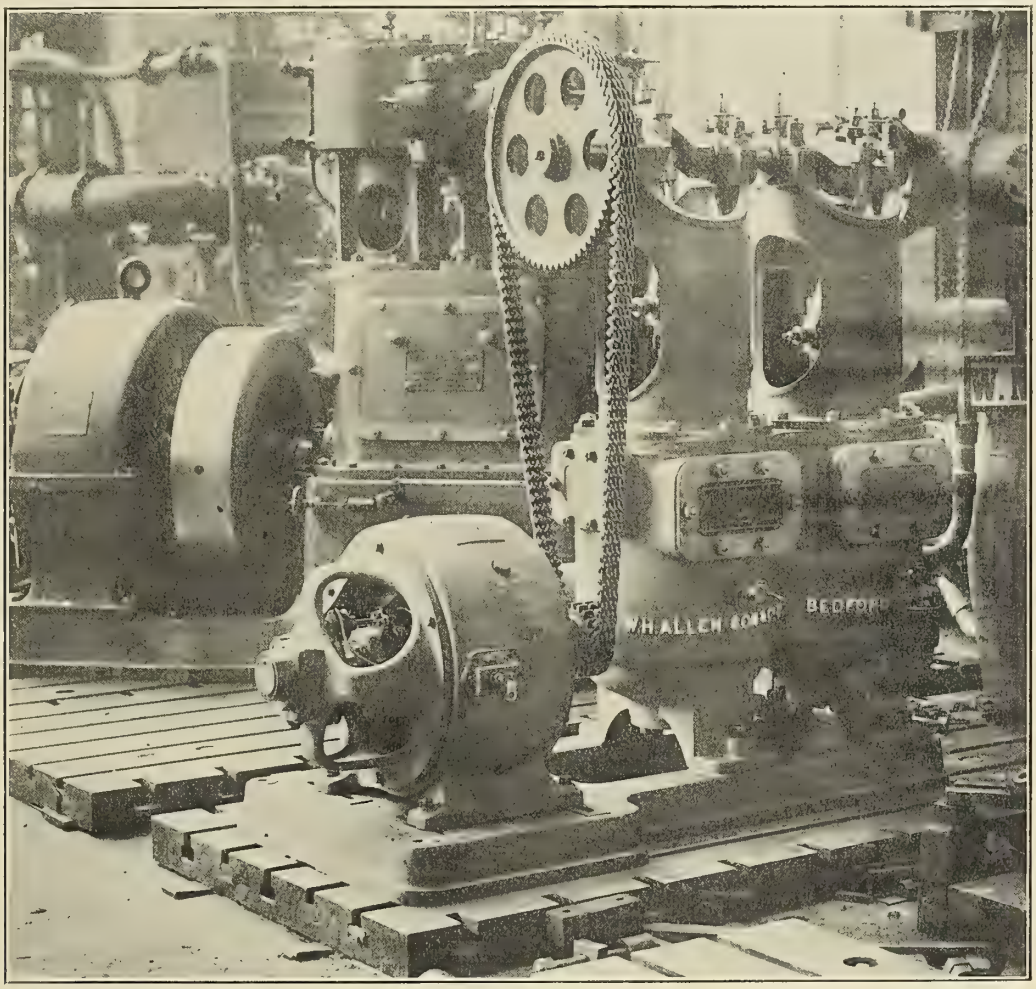


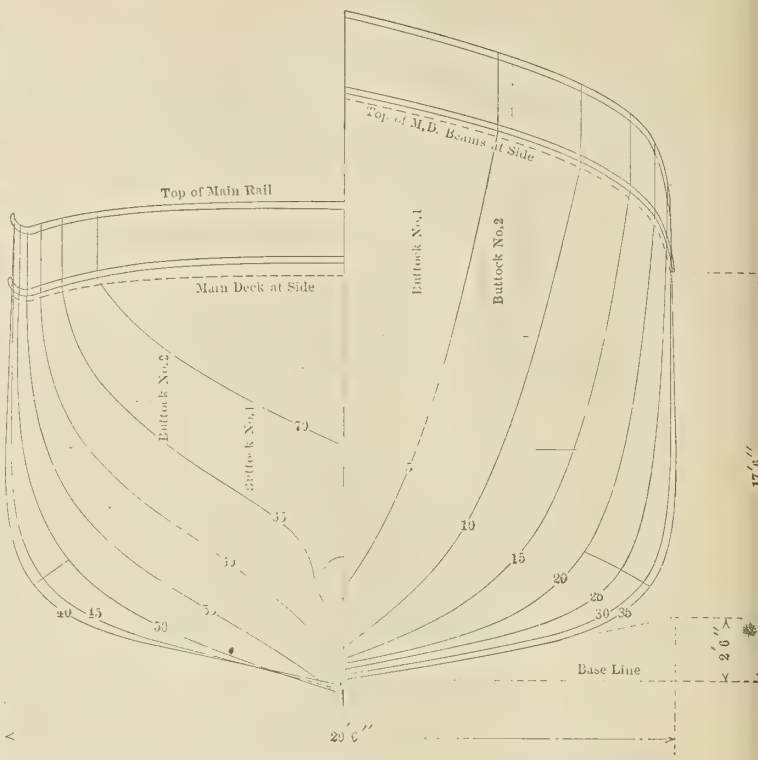
FIG. 5. ELECTRICALLY OPERATED CIRCULATING PUMP FOR EXHAUSTING AIR FROM MAIN PUMPS OF HONG KONG DOCK.

floor stringer plate, worked under the keelson plate on top of floors, is 13 inches wide and of 15-pound steel.

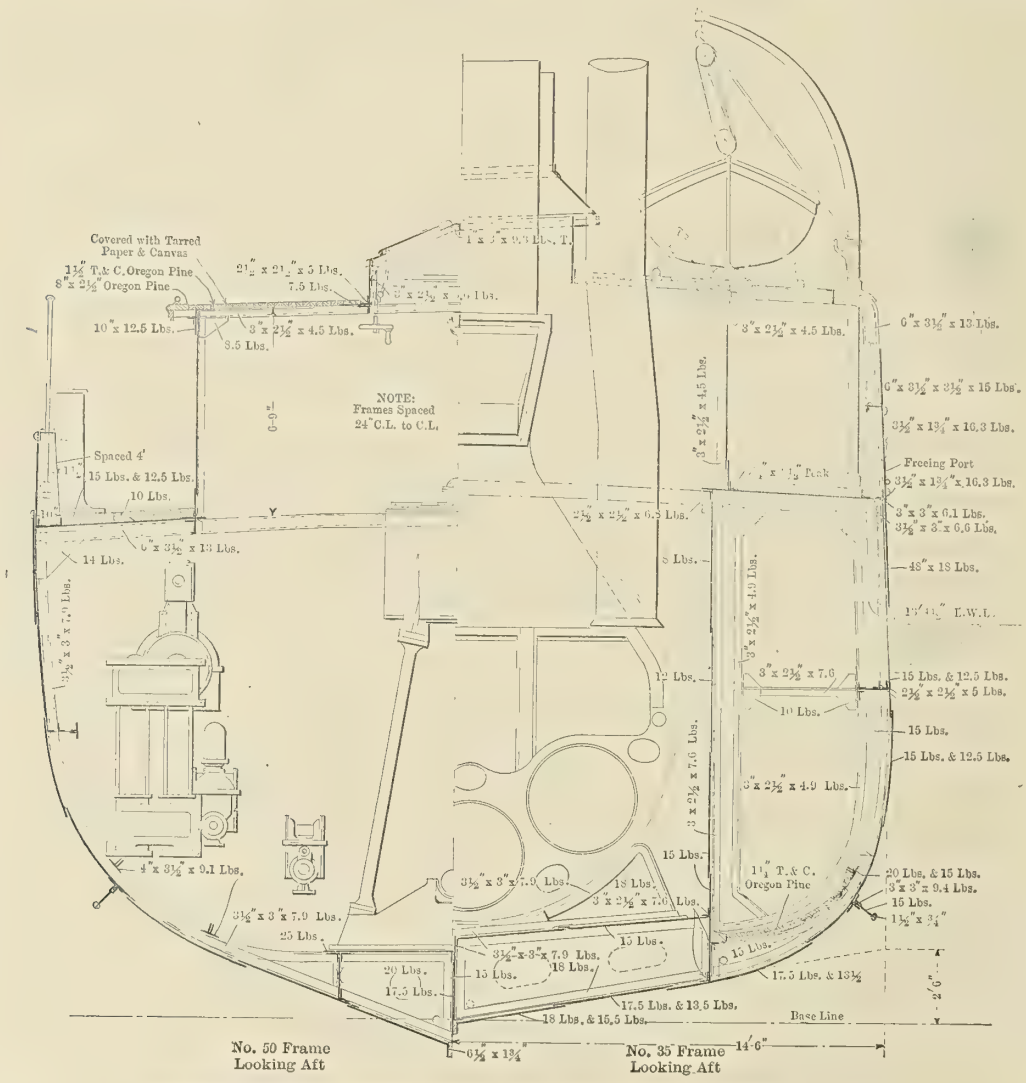
There are two hold stringers and two bilge stringers, each formed of double angles, 4 by 3½ inches by 9.1 pounds. The side stringer will be on a level with the berth deck line, and will extend on each side between bulkheads from frame 24 to frame 56. This is formed of a 12½-pound plate, 12 inches wide, connected to outside plating by intercostal clips, 2½ by 2½ inches by 5 pounds, and to the frames by a continuous angle of the same scantling as the clips. Double continuous angles of this same size are worked on the inner edge of the plate. These are cut at the belt frames, and connected to the reverse bars of those frames by diamond plates, 18 by 18 inches by 15 pounds.

The main deck beams are steel angle bulbs, 6 by 3½ inches by 13 pounds, and fitted on every frame; the camber is 7 inches in 29 feet. In the ward room and crew space the ends of these beams are split and turned down, with a triangular piece welded in. In the engine, boiler and coal bunker spaces and at the ends of the vessel the beams are connected to the frames by 14-pound brackets. The berth deck beams are angles 5 by 3 inches by 8.2 pounds, fitted on alternate frames, except in ward room, where they are on every frame. At side of vessel the tops of these beams will be 8 feet 3 inches below the tops of main deck beams. The berth deck beams will be connected to the frames and to fore-and-aft bulkheads by 12½-pound brackets.

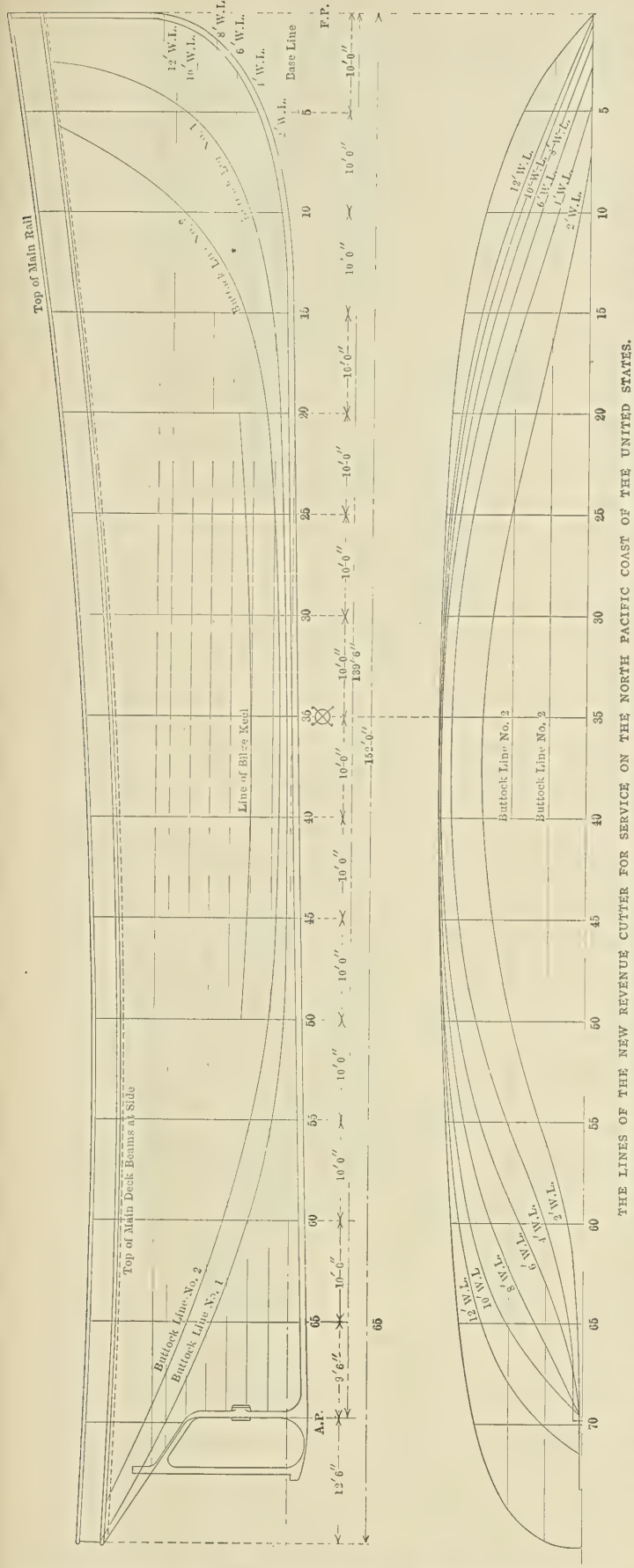
The main deck stringers for one-half length amidships will be 28 inches by 15 pounds, reduced gradually to 19 inches by 12½ pounds at ends. They are worked in lengths of about 20 feet. They are fitted close to the sheer strakes, to which they are



BODY PLAN OF UNITED STATES REVENUE CUTTER NUMBER SIXTEEN.



TRANSVERSE SECTIONS THROUGH ENGINE AND BOILER SPACES, SHOWING SCANTLINGS.



THE LINES OF THE NEW REVENUE CUTTER FOR SERVICE ON THE NORTH PACIFIC COAST OF THE UNITED STATES.

connected on the upper side by continuous angle bars, 3 by 3 inches by 6.1 pounds. The continuous angle forming the gutter-way and backing for the wood deck is 3½ by 3 inches by 6.6 pounds, and so placed as to form a water-way 10 inches wide. Between the stringer plates 10-pound plating will be fitted. The berth deck stringers measure 15 inches by 12½ pounds, and are connected to the outside plating by angle clips, 2½ by 2½ inches by 5 pounds. They are connected to the reverse bars by a continuous angle of the same scantling as the clips. Tie plates, 10 inches by 10 pounds, are worked around hatches.

The skin plating includes garboard plates of 18 pounds; bottom plates, 17½ pounds; bilge plates, 20 pounds; and side plates, 15 pounds; reduced at the ends to respectively 15½, 13½, 15 and 12½ pounds. The sheer strake, which is doubled over the half length amidships, measures 48 inches in width by 18 pounds. The plates on the propeller post hub are 1/16 inch thicker than the midship thickness. Doubling plates at the bow extend about 2 feet above and 2 feet below the mean waterline for 25 feet from the stem. Bulwark plates of 12½-pound steel are fitted in 20-foot lengths. Bulwark stanchions, 4 feet apart, are 1½ inches in diameter, and carry a channel bar at top of bulwark plating, 6 by 3½ inches by 15 pounds.

The inner bottom extends the length of the boiler space, and is connected to the fore-and-aft coal bunker bulkheads and the thwartship bulkheads by continuous angle bars 3 by 2½ inches by 7.6 pounds, calked watertight. The plates throughout are of 20-pound steel.

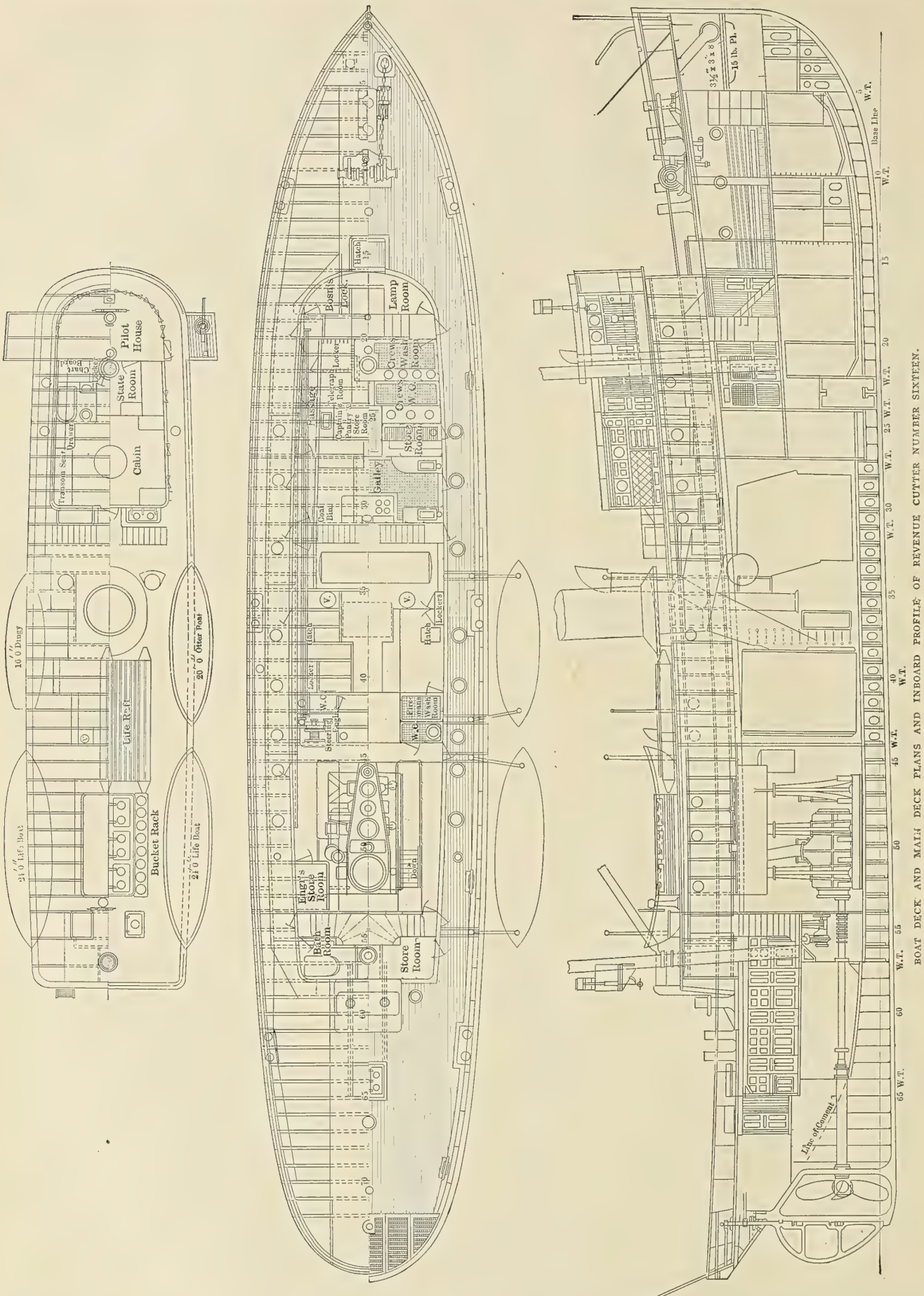
Transverse watertight bulkheads are fitted at frames 5, 10, 24, 27, 44, 57 and 64, the first-mentioned being the collision bulkhead. The latter has plating of 12½ pounds throughout. All other bulkheads have 12-pound plating at the bottom; 10½ pounds at the mid height and 9 pounds at the top. All bulkheads are stiffened on one side by vertical angles 24 inches apart and measuring 3½ by 3 inches by 7.9 pounds. On the other side are horizontal stiffeners, of the same size, 48 inches apart. The fore-and-aft bulkheads forming coal bunkers have bottom strakes of 15 pounds, middle of 12 pounds and top of 8 pounds, the upper edges being connected to main deck plating by angles of 2½ by 2½ inches by 6.8 pounds worked around the beams and made watertight. The bottom plates of these bulkheads are connected to the skin plating by a continuous angle, 3 by 2½ inches by 7.6 pounds, with another continuous angle of the same dimensions fitted at the top of the inner bottom. These bulkheads are stiffened vertically by angles 3 by 2½ inches by 7.6 pounds, 24 inches apart. The fore-and-aft bulkheads forming shaft alley extend between frames 57 and 64, and from the berth deck to the skin plating. The bottom strakes are 15 pounds and upper strakes 12½ pounds. The angles connecting these bulkheads to the skin plating and berth deck are 3 by 2½ inches by 7.6 pounds. Vertical stiffeners, 24 inches apart, measure 2½ by 2½ inches by 5 pounds.

Bilge keels, extending about 60 feet amidships, are formed of 15-pound plates, 12 inches deep amidships and tapered at the ends. They are connected to the skin plating by double angles, 3 by 3 inches by 9.4 pounds, and have on their outer edges double half rounds, ¾ by 1½ inches.

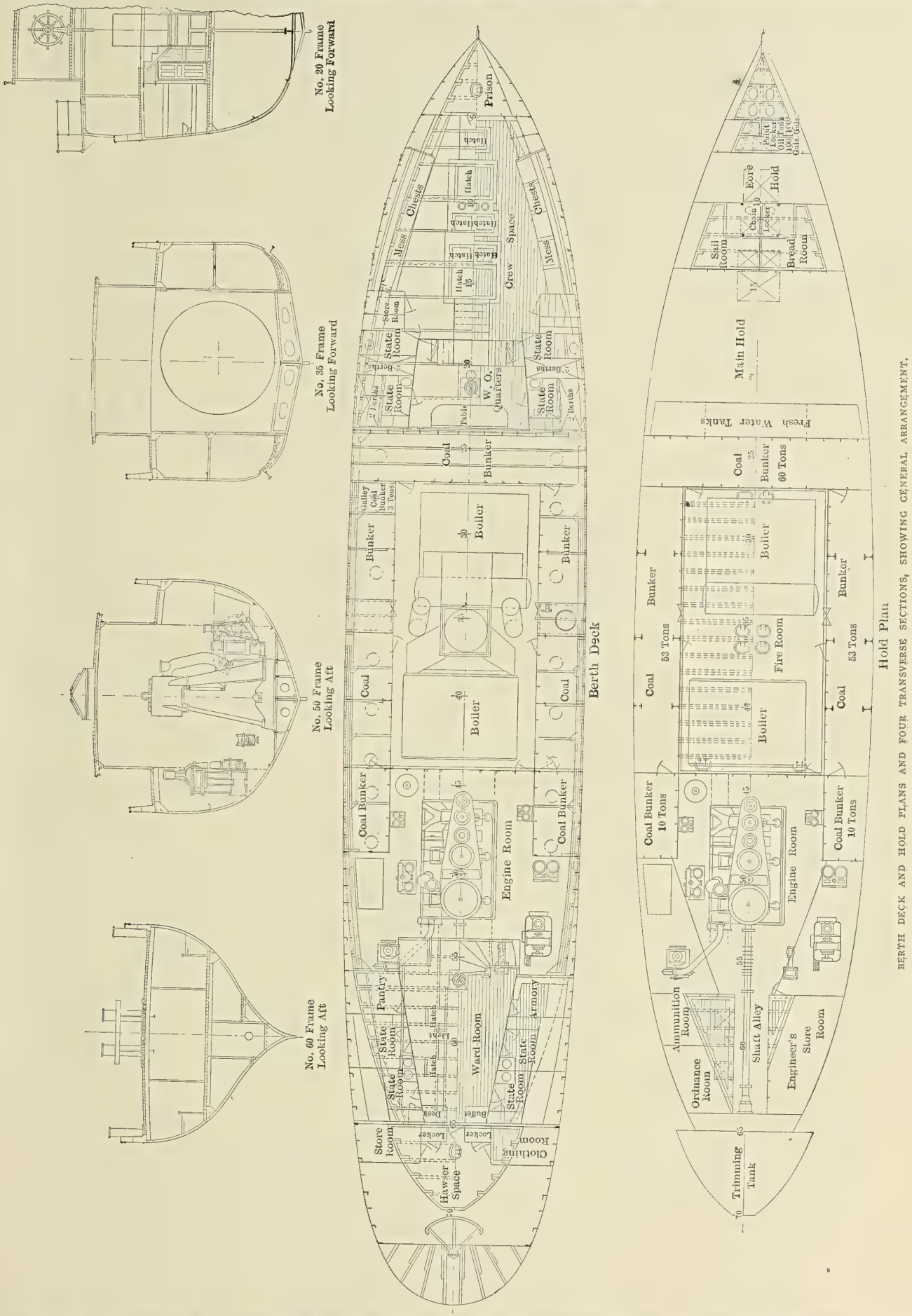
The main engine foundation forms part of the framing of the vessel, including deep floors of 20 pounds, stiffened longitudinally by intercostal plates of 17½ pounds secured to floors and to foundation cap plate by angle clips measuring 3½ by 3 inches by 9.1 pounds. The cap plate is of 25-pound steel. The boiler saddles are of 18-pound plate, bounded with double angles, 3½ by 3 inches by 7.9 pounds.

Trimming tanks are formed by the hull and the watertight bulkheads and flats. The forward tanks are forward of the collision bulkhead, and extend to the berth deck plating. The after tank extends aft from frame 64, and up to the store room flat and berth deck plating. Four fresh water tanks, with a capacity of 800 gallons each, are located at the after end of main hold, and are made of 10-pound plates.

The deck house has a base coaming plate, 12 inches by 12½ pounds, connected to the main deck plating by outside angle, 3½ by 3 inches by 7.9 pounds. The top coaming plate measures 10 inches by 12½ pounds. Intermediate plating is 7½ pounds. Vertical stiffeners, about 2 feet apart, are angles 3 by 2½ inches



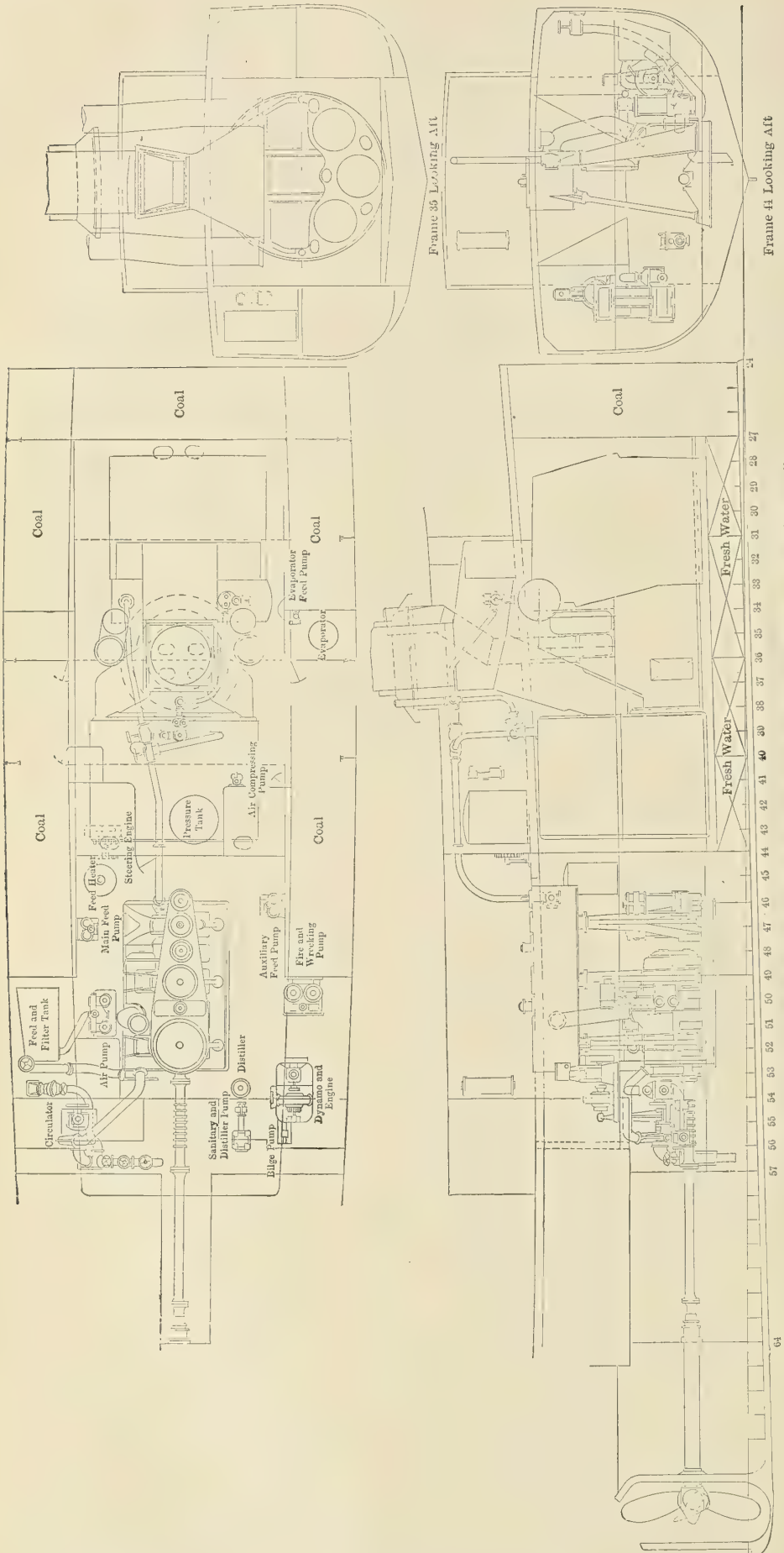
by 4½ pounds. Beams of this same size are fitted to every stiffener, 6 feet 9 inches above main deck beams, and are given the same camber as the latter. The ends of these beams are connected to a continuous fore-and-aft angle of the same scantling. Steel bulkheads inside the house are of 7½-pound plate, stiffened vertically by angles 2 feet apart, measuring 1½ by 1½ inches by



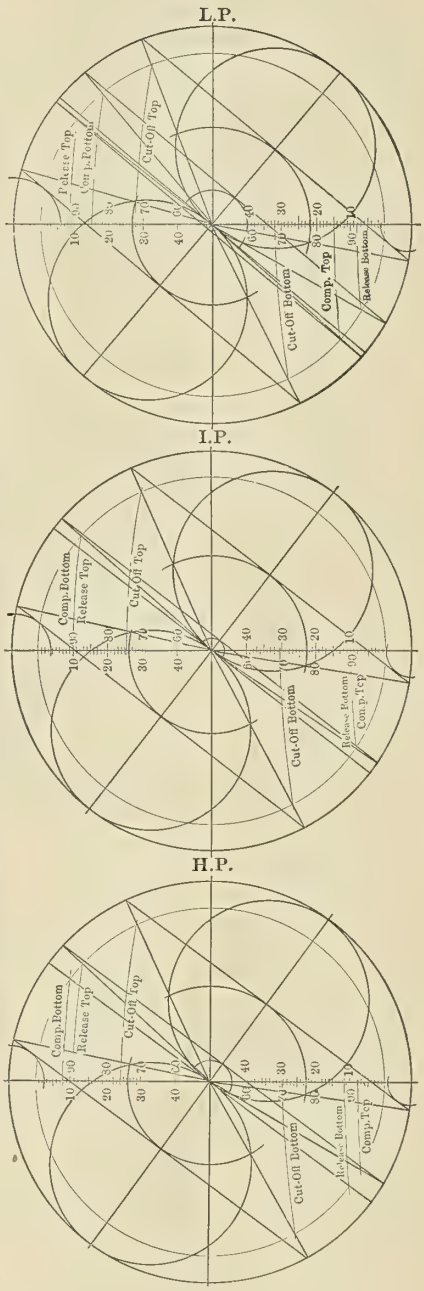
BERTH DECK AND HOLD PLANS AND FOUR TRANSVERSE SECTIONS, SHOWING GENERAL ARRANGEMENT.

2.4 pounds, and have bounding angles of the same size. The bridge across the forward end of the deck house is constructed by extending the beams on each side and covering them with 7½-pound plating. The outer ends of these beams are supported by angle stanchions, 3 by 3 inches by 9.4 pounds. The pilot house and captain's quarters have a clear height under beams of 6 feet 3 inches.

The main deck plank is of teak, 3½ inches thick and 3¾



GENERAL ARRANGEMENT OF THE MAIN AND AUXILIARY MACHINERY AND BOILER PLANT.



VALVE GEAR DIAGRAMS FOR THE THREE CYLINDERS.

inches wide. The berth deck planking is of Oregon pine, 3 by 3 inches. On top of deck house, pilot house and captain's quarters is a planking 1½ inches thick by 3 inches wide, of tongued and grooved Oregon pine, covered with No. 2 and No. 3 canvas respectively.

MACHINERY.

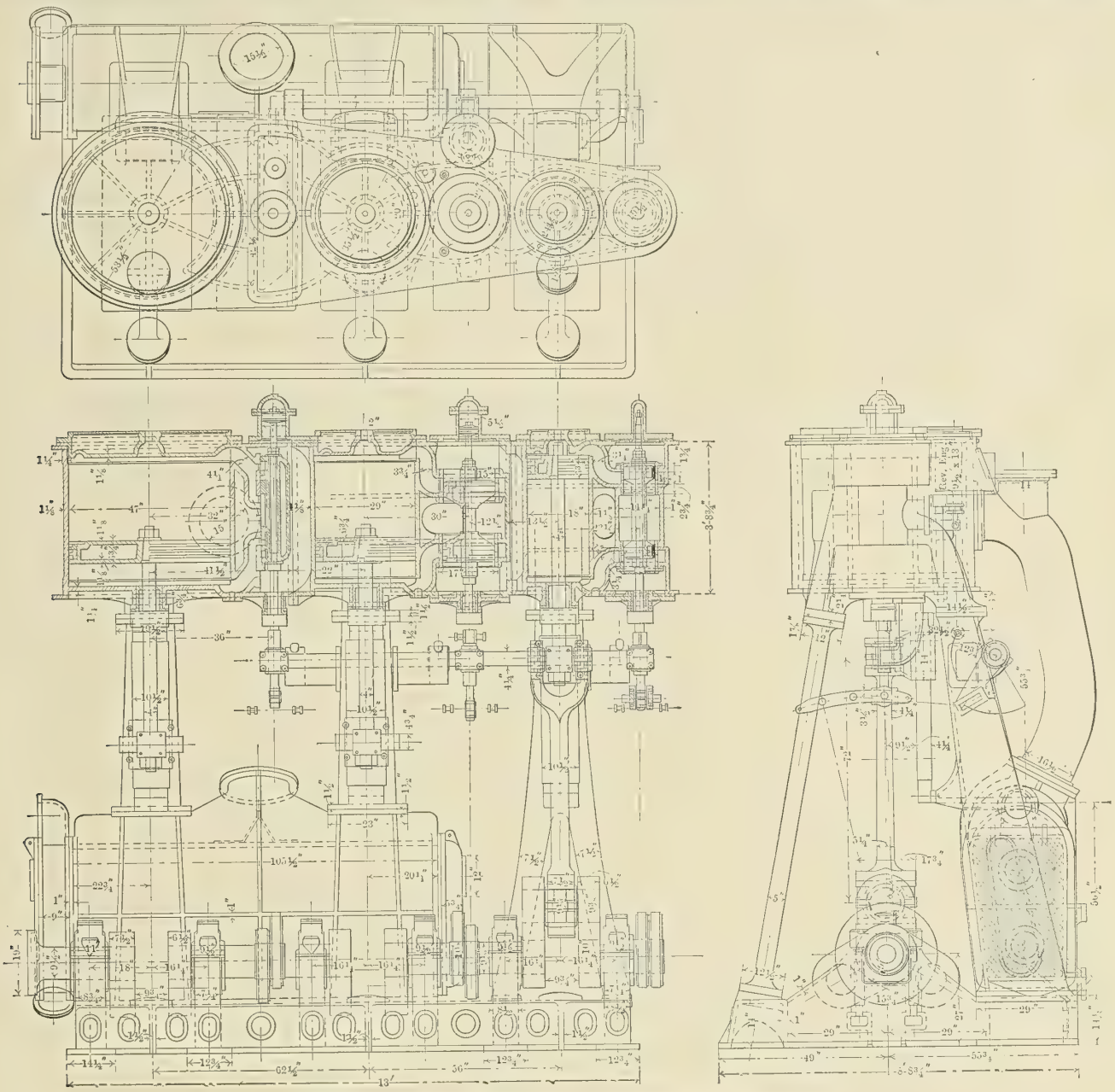
The vessel is to be propelled by a single screw triple expansion engine of 1,200 horsepower, at a designed speed of 12 knots, the cruising displacement being about 760 tons.

The engine has cylinders 18, 29 and 47 inches in diameter, with a stroke of 30 inches, and will be operated at 130 revolutions per minute. The conventional arrangement is adopted of high-pressure cylinder forward and low-pressure aft. The main valves are of the piston type for the two smaller cylinders, while a double ported slide valve is fitted for the low-pressure cylinder. All are worked by Stephenson link motions, with double bar links. The framing of the engine consists of three forged steel columns at the front, and three cast iron columns at the back, two of the latter being bolted to facings on the condenser, which forms part of the framing. The bed plate is of cast iron.

The piston valves for the high and intermediate-pressure cylinders measure respectively 9 and 15 inches in diameter, the working liners in which they operate having a thickness of ¾ inch. The low-pressure valve measures 2 feet 11¾ inches long and 3 feet 9⅜ inches wide. The exhaust passages between successive cylinders are formed by the cylinder castings. From the port side of the low-pressure valve chest a copper exhaust pipe leads to the condenser. This has a diameter of 14 inches at the engine and 15½ inches at the condenser.

The pistons are of cast iron fitted with wrought steel followers. Each piston has three packing rings, ¾ inch thick, with a total bearing surface of 2¼ inches. The piston rods, of forged steel, have a diameter of 4 inches. The crossheads are of forged steel, with pins 4¾ inches in diameter, and measuring 5 inches long on each side. The sliding surface for the crosshead slippers measures 10½ by 14 inches on each side. The crosshead guides are of the bar type, fitted for water circulation. The connecting rods, which are 72 inches between centers, have a diameter at the crosshead end of 4¼ inches, and 5¼ inches at the crank end. The crosshead end is forked to span the crosshead.

The valve gear is so adjusted that the mean cutoff in full gear will be about 0.72 stroke in each cylinder. The point of cutoff will be variable by means of slotted reverse arms. The pins for eccentric rods are 18 inches between centers. The valve stems



LONGITUDINAL SECTION, PLAN AND END ELEVATION OF MAIN ENGINE.

are 2¼ inches in diameter at the stuffing boxes and 1¾ inches in the valves. The eccentrics are made in two parts, the larger being of cast iron and the smaller of forged steel. The eccentricity is 3 inches. The faces of eccentrics are 3¾ inches wide. The eccentric straps are of cast iron in two parts, and are lined with white metal. The distance from center of eccentric to center of link pin is 6 feet 1¼ inches.

There is one section of built-up crank shaft, with three cranks and a coupling disk. The length over all is 15 feet 4 inches. The coupling disk is 2¾ inches thick and 19 inches in diameter. The journals are 9½ inches in diameter, crank pins being 9½ inches by 9¾ inches long. The cranks are set 120 degrees apart, the high-pressure leading, followed by the intermediate. The crank webs are 6½ inches thick, measure 17 inches wide at the crank pin end and 18 inches wide at the shaft. The after low-pressure web is 7½ inches thick. The thrust shaft is 9 inches in diameter and 7 feet 3 inches long, and is fitted with eight thrust collars, 4 inches apart, 1¾ inches wide and 15 inches in diameter. A coupling disk is forged on each end, 2¾ inches thick and 19 in diameter. The intermediate shaft, 9 inches in diameter, is about 11 feet long, with coupling disks at each end. The propeller shaft has a diameter of 9½ inches, and is fitted in a composition casing, shrunk on the shaft in sections 30 inches long. A coupling disk is fitted at the forward end.

The crank shaft has six bearings, of 9½ inches in diameter and 9½ inches long, except that the after low-pressure bearing is 11 inches long. The thrust bearing consists of a cast iron pedestal fitted with nine cast iron horseshoe collars lined with white metal. The intermediate shaft will be carried upon two spring bearings made of cast iron. The propeller shaft will be supported in the stern tube on two bearings, one at each end of the tube. The after bearing will be 3 feet long, and the forward bearing 12 inches. The stern tube is of cast iron, 1¼ inches thick with two internal flanges, one forward of the after bearing and one aft of the forward bearing. The internal diameter of the flanges, which are 1½ inches wide, will be bored to 11¾ inches. The flanges will be faced, and the ends of the stern tube will be bored to a diameter of 13½ inches. The after end of the tube will be 16 inches in diameter, and will have a 1¾-inch external flange, 17½ inches in outside diameter. The bearings in the stern tube will be lined with lignum vitae.

The propeller, which is of manganese bronze, is right handed, has four blades and is built up. The diameter is 11 feet. Each blade is fastened to the hub by tap bolts of rolled bronze. The blades will be slightly canted aft, the center at the periphery being about 12 inches aft of the center of the hub.

AUXILIARY MACHINERY.

Reversing Gear.—A steam cylinder, 9½ inches in diameter and 13 inches stroke, secured to the casing of the intermediate-pressure cylinder, is used for reversing the main engine. A slide valve of cast iron governs the action of this cylinder.

Condenser.—The surface condenser is of rectangular shape, with a semi-cylindrical top. It will be cast iron, with a general thickness of 1⅛ inches. The shell measures 8 feet 9½ inches between tube sheets, 2 feet 5 inches wide and 4 feet 4½ inches high inside. The main exhaust enters the condenser through a pipe 15½ inches in diameter. The tube sheets are of rolled bronze 1 inch thick. There are 1,151 seamless drawn condenser tubes, made of a composition containing sixty percent of copper and forty percent of zinc. These tubes have an outside diameter of ⅝-inch, a thickness of No. 18 U. S. S. G., and are 8 feet 11½ inches long. They are spaced 15/16 inch center to center, and are heavily tinned inside and out. The cooling surface, measured on the outside of the tubes, is 1,657 square feet. The inlet and outlet nozzles for circulating water have diameters of 8 inches.

Feed and Filter Tank.—This tank is built up from the frames of the vessel, and has a capacity of 350 gallons. It is made of wrought iron plates, ¼ inch thick. Zinc plates in wrought iron baskets are suspended in the tank to guard against pitting.

Feed Water Heater.—The heater is located in the engine room, and uses auxiliary exhaust steam. The heating surface is 120 square feet, measured on the steam side of the tubes.

Air Pumps.—A single-acting independent vertical air pump is fitted, having two direct acting steam cylinders, 8 by 12 inches, placed in line with two air cylinders, 16 by 12 inches. The steam distribution is regulated by slide valves, operated by an auxiliary piston working in a horizontal steam cylinder and fitted with a small slide valve. The air pump and condenser are required to maintain a vacuum within 4 inches of absolute. The suction and discharge pipes are respectively 7 and 6 inches in diameter.

Circulating Pump.—This is of the centrifugal type, with perfectly balanced runner, 24 inches in diameter. The shaft is an extension of the engine shaft and is of rolled bronze. The pump will be driven by a vertical engine, 7 by 7 inches, of the open type, the cylinder being supported on a cast iron column at the back and a steel rod at the front. The suction and discharge nozzles measure 8 inches.

Main Feed Pump.—This is a vertical double-acting duplex piston pump, having two steam and two water cylinders, respectively 8 and 5 inches in diameter, with a stroke of 12 inches. It is located in the engine room. The suction nozzle has a diameter of 4 inches, and the discharge nozzle 3½ inches.

Auxiliary Feed Pump.—This is similar to the main feed pump.

Fire and Wrecking Pump.—This is of the same type as the feed pumps, but has steam and water cylinders, 14 and 8½ inches in diameter, with a stroke of 12 inches. The suction and discharge pipes measure respectively 7 and 6 inches in diameter.

Bilge Pump.—This is of the horizontal double-acting simplex type, with steam and water cylinders 8 and 9 inches in diameter and a stroke of 10 inches. The suction pipes measure 5 inches in diameter; discharge pipes, 4, 3½ and 2 inches

Distiller Circulator and Sanitary Pump.—This is horizontal, double-acting, simplex, with steam and water cylinders, 6 and 7 inches in diameter, and a stroke of 7 inches. Suction, 3 inches; discharge, 3, 2½ and 2 inches.

Evaporator Feed Pump.—This is vertical, double-acting, simplex. with steam and water cylinders 3½ and 2½ inches in diameter, and a stroke of 4 inches. The suction and discharge pipes are respectively 1 and ¾ inch in diameter. It is located in the evaporator room.

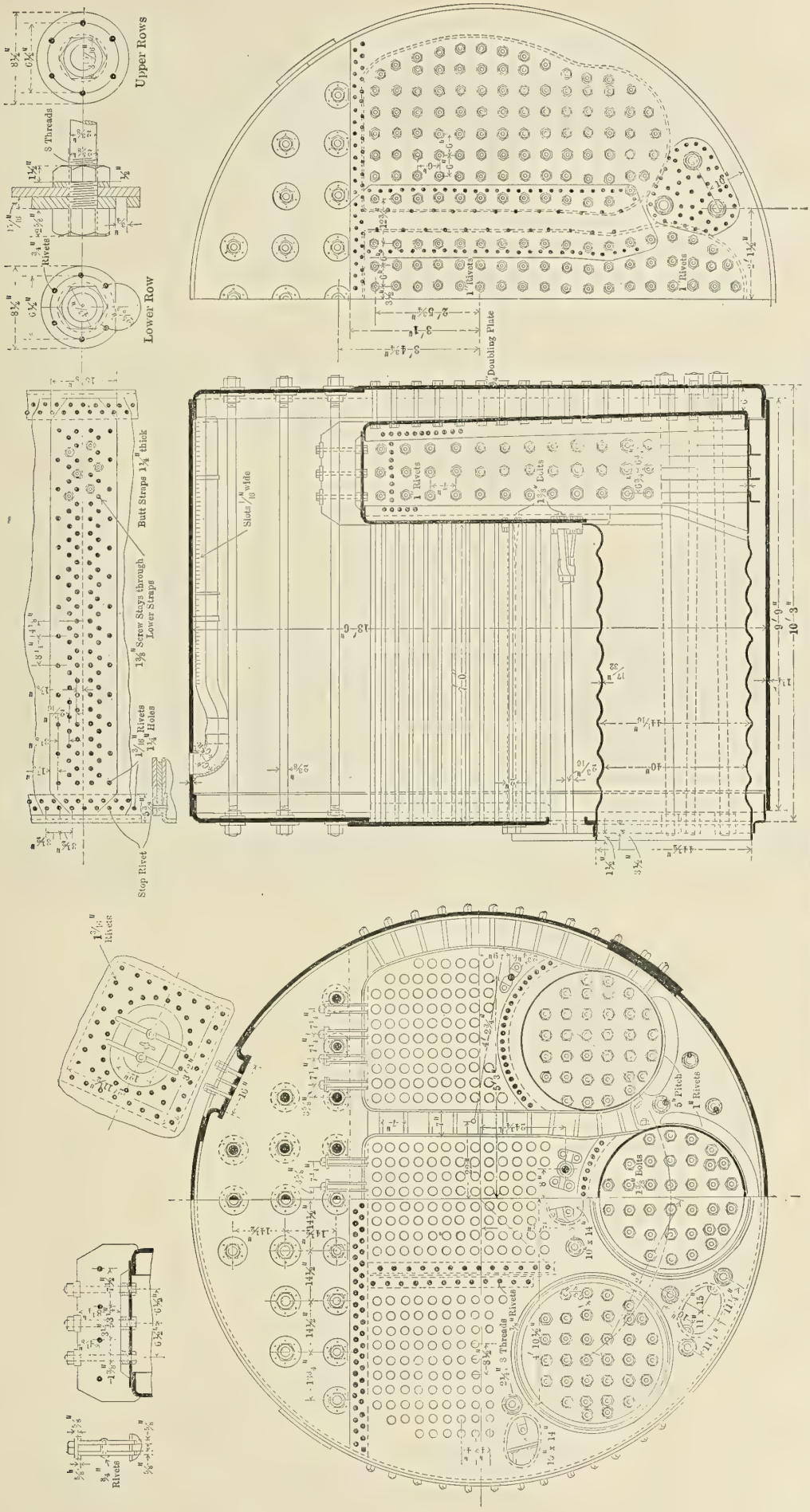
Air Compressing Pump.—This is vertical simplex, with steam and air cylinders 4½ and 5½ inches in diameter, and a stroke of 6 inches. It is located in the upper part of the fire room.

All of the pumps, except the last two, are located in the engine room.

BOILERS.

Two boilers are fitted, one of the Scotch marine type and one of the watertube type. Both are in the same watertight compartment, and are designed for a working pressure of 180 pounds per square inch. The watertube boiler has a length over casing at bottom of 10 feet 4 inches; a width of 12 feet 9 inches; a height to center of drum, 13 feet 3 inches. The tubes are 9 feet long, and with a grate surface of 78.5 square feet and heating surface of 2,565 square feet, shows a ratio between the two of 32.7 to 1.

The Scotch boiler has an inside diameter of 13 feet 6 inches; a length over the heads of 10 feet 3 inches; and is fitted with three corrugated furnaces with an inside diameter of 40 inches. The grate surface measures 60 square feet; heating surface, 1,803 square feet; ratio, 30 to 1. The shell is made in one course, and consists of two plates, 1¼ inches thick. Each head of the boiler consists of two plates, of which the upper and lower have thicknesses respectively of 15/16 and ¾ inch. The tube sheets are ¾-inch thick. The tubes have an external diameter of 3 inches, and a thickness represented by No. 10 U. S. S. G. Stay tubes of the same diameter are of No. 6 U. S. S. G. There are 196 of the ordinary tubes and 72 stay tubes. The aggregate cross sectional area of the tubes is 10.72 square feet. The grate surface



THE SINGLE-ENDED SCOTCH BOILER, WITH DETAILS OF STAYS, CROWN BARS, RIVETING AND MANHOLE DOUBLING PLATES.

is 5.6 times this area. The tubes measure 7 feet between sheets. With water 6 inches above the top row of tubes, the steam space measures 310 cubic feet. The estimated weight of this boiler, without water or fittings, is 70,560 pounds. The estimated weight of water is 39,200 pounds. This boiler is offset about 6 inches on the port side of the vessel, to provide for a passage on the starboard side.

The shell of the boiler was figured on an assumed factor of safety of 4.3. The efficiency of the longitudinal seam of the boiler, with a pitch of 8.25 inches between rivets, and rivet holes 1.25 inches in diameter, is found to be 84.84 percent. The efficiency of the rivet connection, figured on the basis of the rivets themselves, is 85.45 percent. The total grate surface in both boilers is 138.5 square feet, and the total heating surface 4,368 square feet. This gives a ratio between the two of 31.5 to 1.

The funnel, which serves both boilers, is 47 feet high above the grates, and has an inside diameter of 5 feet 2 inches, thus giving a clear area of about one-seventh the grate area. The inner and outer casings are respectively of No. 7 and No. 12 U. S. S. G. plates. Stiffeners within the air space consist of four angles extending the full length of the pipe.

EQUIPMENT.

The steam heating system is designed with radiators having about 30 square feet of heating surface for each thousand cubic feet of space heated. The evaporating and distilling plant has a capacity for producing 1,700 gallons of water per day.

The steam steering engine, with two cylinders 4½ by 4½ inches, is located just above the Scotch boiler on the port side. The steam windlass, with two cylinders 6 by 8 inches, is connected to the windlass and gypsy heads. The windlass is arranged for two wildcats and two gypsy heads. The steam gypsy or hawser puller has two cylinders, 5 by 7 inches.

The electric lighting installation includes a 15-kilowatt direct connected generating set, with lights, searchlights and signaling apparatus. The working pressure will be about 115 volts. One hundred and twenty incandescent fixtures of 16 candlepower will be scattered throughout the ship. Thirty-two-candlepower lamps will be provided for special service. Two 18-inch searchlights are to be fitted, one forward and one aft. Two stockless bower anchors, of 2,240 pounds each, will be carried, besides one anchor of 560 pounds and two of 350 pounds each. The anchor davit has a maximum diameter of 4¾ inches and an outreach of 4 feet 6 inches.

There will be carried two 24-foot metallic lifeboats, one 20-foot boat, one 16-foot dinghy and one 17-foot metallic life raft. The boats are to be carried on four pairs of davits, the after pair being 5 inches in diameter and the forward pair 4 inches.

The masts are of Oregon pine, in one length from heel to truck. Each measures 63 feet from heel to head, and has a 7-foot pole on top. At the main deck partners the diameter is 16 inches. The rake of the masts is about 3½ degrees for the foremast and 4½ degrees for the mainmast.

Two 1-pounder guns will be fitted, one on each side of the bridge. Rail mounts for a line and throwing gun will be fitted on each side of the main rail, forward and aft.

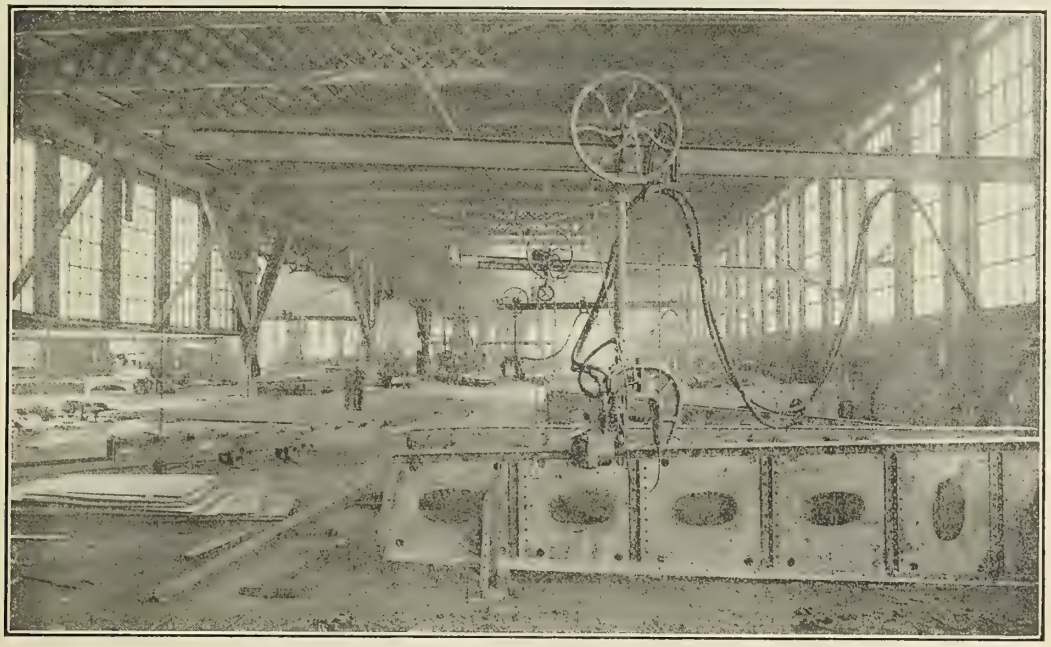
THE SOUTH YARD OF THE QUEEN'S ISLAND ESTABLISHMENT.

VALVE DIAGRAM DATA.

	H. P.	I. P.	L. P.
Eccentricity	2⅞	2⅞	2⅞
Travel of valve	5¾	5¾	5¾
Width of port	1 15/16	2⅛	two 2⅛
Steam lap, top	1⅜	1⅜	1 13/32
Bottom	1 3/16	1 3/16	1 5/32
Exhaust lap, top	—5/16	—3/16	3/32
Bottom	0	3/16	½
Steam lead, top	5/16	⅜	7/16
Bottom	½	9/16	11/16
Cutoff, top	0.759	0.746	0.722
Bottom	0.707	0.695	0.679
Release, top	0.894	0.899	0.913
Bottom	0.886	0.9	0.92
Compression, top	0.077	0.101	0.148
Bottom	0.079	0.1	0.151
Steam opening, top	1½	1½	1 15/32
Bottom	1 11/16	1 11/16	1 23/32
Square inches, top	31.9	56.5	114.5
Square inches, bottom	34.8	63.5	134
Exhaust opening, square inches	40.25	80	165
Steam velocity, ft. per min., top	5,200	7,620	9,850
Bottom	4,820	6,775	8,420
Exhaust velocity, ft. per minute	4,120	5,375	6,830
Velocity through steam pipe	5,850	.....	.....
Velocity to condenser	.....	.....	4,975

THE HARLAND AND WOLFF SHIPBUILDING PLANT.

The largest shipbuilding plant in Ireland, and, in some respects, the largest in the world, is that of Harland & Wolff, of Belfast. A small yard on Queen's Island, in Belfast, was in operation before the middle of the nineteenth century. In 1861 the manager of this yard, who was later Sir Edward Harland, entered into partnership with Gustavus Wolff, and since then the present firm has carried on the work with ever increasing magnitude of operations. The present head of the firm, Lord Pirrie, was made a partner in 1874, and has for some time been chairman of the company.

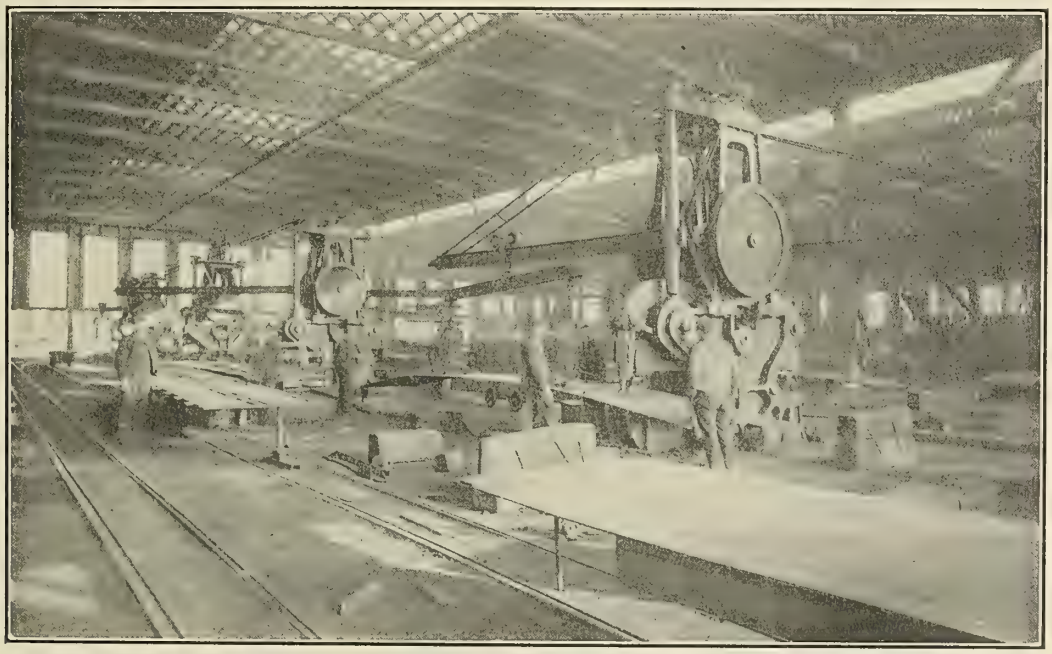


PNEUMATIC RIVETING SHED, SHOWING MACHINE AT WORK ON DOUBLE BOTTOM GIRDER.

The works are entirely self-contained, as not only are ships built here, but also the engines for propelling them, and all the various equipments and fittings required in ship construction, including joinery, cabinet work and upholstery. There are building berths at either end of the yard, with shops intermediate for plates and angles. These shops are thus most convenient for use in connection with operations at any part of the establishment. The engine works are just across the road, and the entire plant is situated with convenient reference to the docks and fitting-out berths.

The main offices occupy a central position; and incorporated with them are the drawing offices, where the ships are first designed, and where afterwards models and working drawings are prepared.

The mold loft, of which we present an illustration, is of great size, for the purpose of laying down on full scale the lines of a projected vessel, which are later transferred to the scrieve board in the frame shed. It is said that in this yard obtains to a very large degree an intimate and perfect co-operation among the several departments, such that when the hull of the vessel is ready to take the water, the engines and boilers and other features of the equipment are ready to be installed.



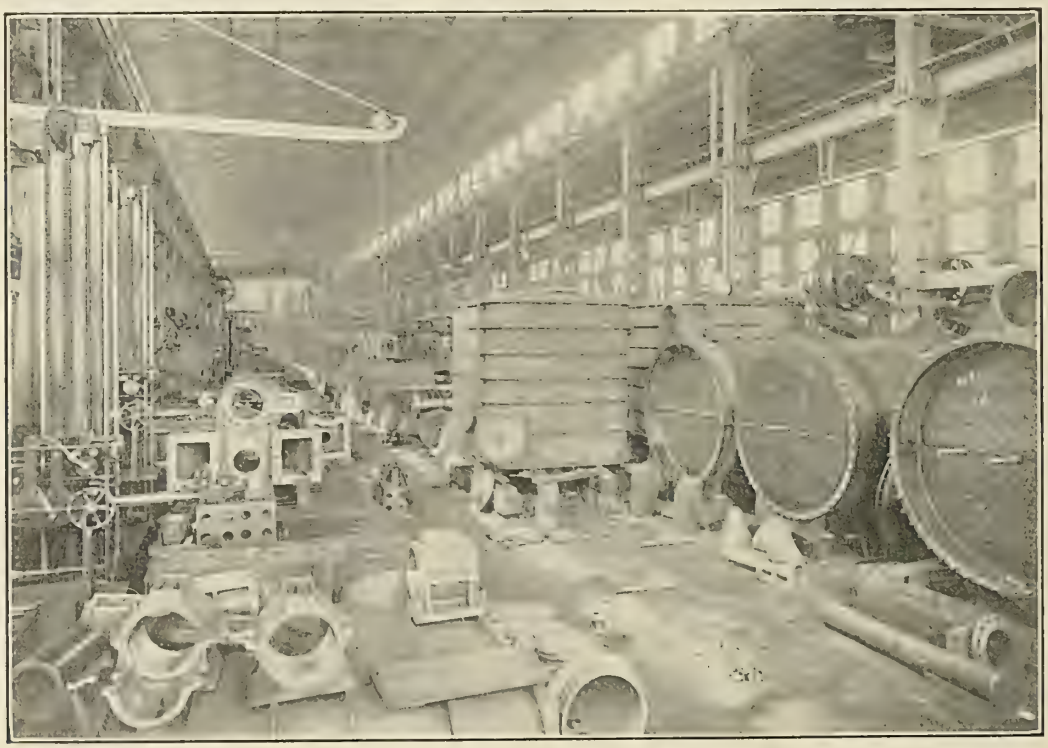
PUNCHING AND SHEARING MACHINES IN THE PLATERS' SHED.

This yard has turned out some of the most notable productions

THE IMMENSE MOLD LOFT OF THE HARLAND AND WOLFF SHIPYARD.

in the great mercantile fleets of today, including practically all of the White Star liners, such as the *Oceanic, Celtic, Cedric, Baltic* and *Adriatic,* while notable among the later productions is the *Amerika,* of the Hamburg-American Line. A special feature in the construction of ships by Harland & Wolff is the cleanness of the lines, both below water and above; while a point which usually indicates a ship from this establishment is the complete cutting away of the forefoot of the vessel, from the bow to a point 60 or 80 feet aft of the bow at the keel. This makes the ships somewhat easier to manage with the rudder, and has been adopted in almost all ships built by the firm. The machinery which has been placed in the latest vessels has been invariably on the balanced system, with the idea of reducing vibration when at sea.

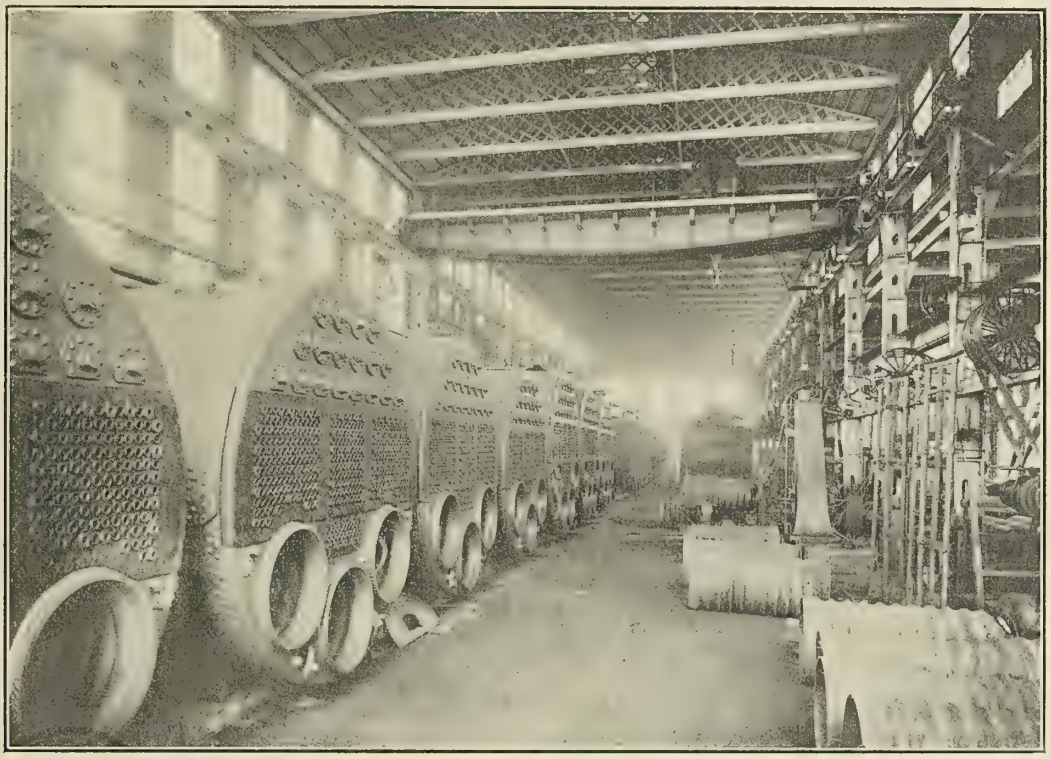
Harland & Wolff are said to have been responsible for the fitting in several ships of the British government of a combination of Scotch and watertube boilers. In the incipient stages of the development of the latter, it was found to be impossible to



MACHINE TOOLS IN THE ENGINE ERECTING SHOP, WITH CONDENSERS UNDER CONSTRUCTION.

attain the extreme economy shown by the former, and hence cylindrical boilers were fitted to furnish about one-fifth the total steam required for full power. These boilers were used for cruising purposes, and, being worked at nearly full capacity, gave splendid efficiency. The watertube boilers fitted in conjunction with them, and covering the balance of the power, were designed for the same working pressure, and were used only when it became necessary to go above a certain low speed designated for cruising purposes. The efficiency of watertube boilers having recently been largely augmented, the practice of combining the two types in one vessel has been found unnecessary, and it is no longer done.

A sufficient indication of the extent of work carried through by this company is had by a glance at the table following:



THE BOILER SHOP, WITH A ROW OF COMPLETED BOILERS OF VARIOUS SIZES.

Period.	Vessels built.	Gross tons.	Annual average.	Average size.
1859-1862	13	16,162	5,387	1,243
1862-1867	38	32,805	6,561	863
1867-1872	31	47,246	9,449	1,524
1872-1877	32	39,496	7,899	1,234
1877-1882	37	81,318	16,264	2,198
1882-1887	52	129,090	25,818	2,483
1887-1892	58	259,981	51,996	4,482
1892-1897	57	354,757	70,951	6,224
1897-1902	33	414,477	82,895	12,560
1902-1906	33	310,830	77,708	9,429
1859-1906	384	1,686,162	35,876	4,391

That this company has been pre-eminent in the building of very large ships is easily shown. Taking 10,000 tons gross as the line of demarcation between very large vessels and other vessels, this firm had constructed, up to the end of 1905, forty vessels of the largest type, with a total tonnage of 556,367 gross, or an average of 13,909. All other shipbuilders, British and foreign, had built up to the same date sixty-one such steamers, aggregating 771,450 gross tons, or an average of 12,646 tons each. In 1903 the company launched seven vessels aggregating 110,463 gross tons, or an average of 15,780 tons each.

Long Distance Ocean Race for Motor Boats.

Under the auspices of the two clubs, a motor boat race is to be run in June, 1907, from the station of the Motor Boat Club of America on the Hudson river to a stake-boat in the Bermuda Islands suitably placed by the Royal Bermuda Yacht Club. The race, which will be for a trophy presented by James Gordon Bennett, of the *New York Herald*, will start at three P. M., June 8. Some of the conditions specified as governing the race are as follows:

It shall be open to sea-worthy motor boats, measuring not less than 39 feet or more than 60 feet over all, being substantially built and fully decked, with motor power and living accommodations housed in, and equipped with all tackle and appliances necessary for a long passage in open water. Any form of internal combustion motor may be employed for propulsion purposes. The fuel carried must be sufficient to complete a distance one and one-half times that between New York and Bermuda. No ingredient shall be used to increase the power of fuel. The boats must be equipped with suitable spars and rigging to carry sufficient sail to give them steerage way in an ordinary breeze. The total area of canvas must not exceed 6 square feet for each foot of over-all length, but such as is carried may be in any form desired. A steering sail and storm tri-sail may also be carried.

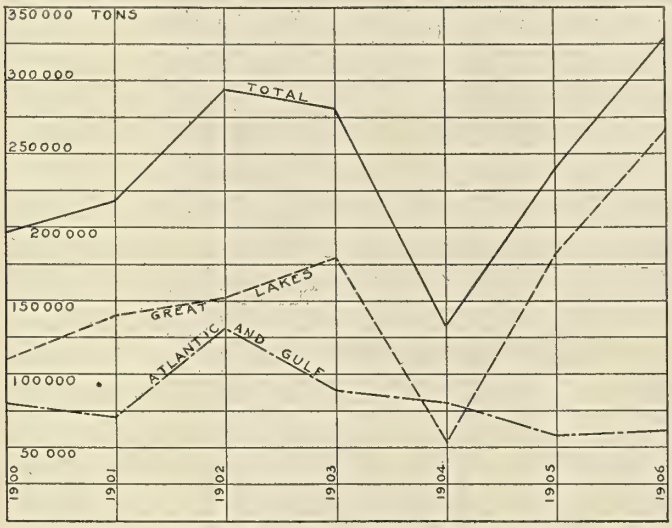
No boat may start with less than five men on board of her; one shall be a practical navigator, one a practical engineer and at least half of the crew must be amateurs. It is recommended that no member of any crew shall be under twenty-one years of age, and that all shall have had previous nautical experience. Stores and water must be carried sufficient for thirty days. A tender or life raft must be carried, and a ring buoy or life jacket for each member of the crew. A full set of navigating instruments, spare compass, sea anchor, oil bag and at least one gallon of crude petroleum or other oil must be carried, as well as fire extinguishers, suitable arrangements for fitting an emergency tiller and an assortment of spare parts and gear. Fuel must be carried in at least two distinct tanks, with separate feed lines to the engine or engines. Fuel for lighting or cooking may be

carried in separate receptacles. Water must be carried in at least two separate tanks, securely fitted and fastened to the hull.

The rating will be calculated under the 1905 rules of the American Power Boat Association, except that the constant used in figuring the horsepower of two-cycle motors will be 850 instead of 750. The time allowance will be figured at 50 percent of the Association time allowance table; the distance for computation of allowance being on a basis of 650 miles. Entries will be received up to twenty days before the start by the secretary of the Motor Boat Club of America, 314 Madison avenue, New York. All contestants must be officially measured at least forty-eight hours before the start.

Shipbuilding in the United States.

The Bureau of Navigation of the Department of Commerce and Labor reports the construction in the United States during



STEEL STEAMSHIP TONNAGE BUILT IN THE UNITED STATES.

the calendar year 1906 of 1,045 vessels, aggregating 393,291 tons gross, as compared with 1,054 vessels of a total of 306,563 in 1905.

VESSELS BUILT IN THE UNITED STATES.

Year	Ships	Gross Tons	Average Tons	Great Lakes Ships	
				Gross Tons	Percent
1900	1,102	365,791	332	129,973	35.6
1901	1,322	376,129	284	156,157	41.5
1902	1,270	434 005	342	158,230	36.5
1903	1,159	381,970	330	182,593	47.8
1904	1,063	265,104	249	54,042	20.4
1905	1,054	306,563	291	182,361	59.5
1906	1,045	393,291	376	268,085	68.2

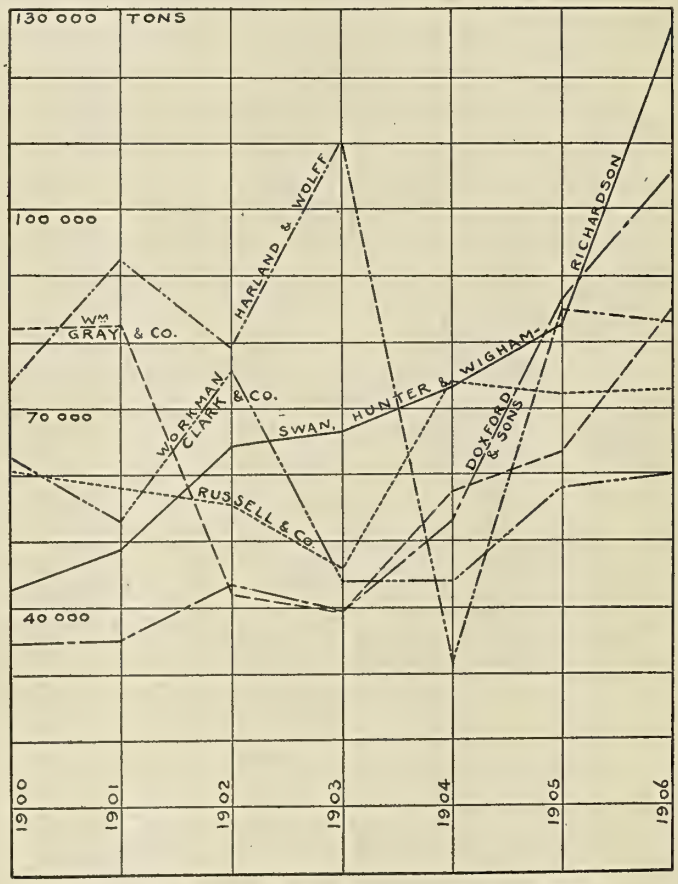
STEEL STEAMERS BUILT IN THE UNITED STATES.

Six Months Ending	Totals		Atlantic and Gulf		Great Lakes	
	Ships	Gross Tons	Ships	Gross Tons	Ships	GrossTons
June 30, 1900	52	105,713	31	34 803	17	63,885
Dec. 31, 1900	40	91,244	20	44,179	16	44,626
June 30, 1901	64	144,021	31	46,297	30	91,994
Dec. 31, 1901	40	74,604	21	25,541	17	49,020
June 30, 1902	74	196,197	34	76,186	32	109,019
Dec. 31, 1902	42	98,516	26	52,385	12	43,248
June 30, 1903	69	153,389	33	54,411	29	88,412
Dec. 31, 1903	50	126,392	20	36,077	28	89,562
June 30, 1904	43	113,261	27	61,904	13	50,336
Dec. 31, 1904	31	19,472	25	16,955	5	2,498
June 30, 1905	42	139,883	17	39,822	24	99,999
Dec. 31, 1905	51	100,127	27	18,843	21	80,932
June 30, 1906	58	181,614	25	24,378	31	156,792
Dec. 31, 1906	56	146,177	33	35,895	21	109,471

Of the total for the year no less than 268,085 tons are accounted for by construction on the Great Lakes. This represents 68.2 percent of the total construction in the country. On the Atlantic seaboard the construction during 1906 amounted to 104,529 tons in 606 vessels, thus showing an average of 172 tons only. The tables and chart require no explanation.

Shipbuilding in Great Britain in 1906.

British shipbuilding during the year just closed appears to have been remarkable in its extent. Figures at hand show that the total on the Clyde aggregated 606,000 tons, as compared with 544,400 tons in 1905. On the northeast coast the aggregate was 1,090,507 tons, compared with the 1905 figure of 976,842 tons. On the Humber the construction in 1906 was 36,670 tons, as against 34,845 in 1905. On the west coast four vessels were launched, amounting to 26,770 tons, none of them being mercantile; last year the figure was 41,500.



TONNAGE CONSTRUCTED BY SIX PROMINENT BRITISH FIRMS.

Outputs for individual firms show in many cases very large increases over all preceding years. First place is held by Swan, Hunter & Wigham Richardson, with twenty-five vessels aggregating 126,921 tons, as compared with 82,727 tons last year. Next comes William Doxford & Sons, with twenty-five turret ships aggregating 106,058 tons, as compared with 86,632 tons in 1905. Third place is held by William Gray & Company, with a total of twenty-four vessels aggregating 85,111 tons, as compared with 63,226 tons last year. Harland & Wolff, of Belfast, launched eleven vessels aggregating 83,238 tons, as compared with 85,287 for last year. The fifth concern is the largest on the Clyde, being Russell & Company, of Port Glasgow, with fourteen vessels, amounting to 72,730 tons, as compared with 71,540 tons in 1905. The only other yard which has turned out upwards of 50,000 tons is the Northumberland Shipbuilding Company, credited with eleven vessels aggregating 51,400 tons, as compared with 45,805 tons in the previous year.

Of course it goes without saying that more than 26 percent of the output of the leaders in this year's race may be traced to

the one Cunard ship *Mauretania,* launched by them in September. The other Cunarder, which was launched by John Brown & Company on the Clyde in June, formed more than two-thirds of the total output of that firm, the aggregate being seven vessels of 46,387 tons, as compared with 20,606 tons last year.

The aggregate for the United Kingdom appears to be about as follows:

	1906.	1905.
The Clyde	606,000	544,400
The Tyne	418,493	368,845
The Wear	345,409	323,589
The Tees	154,424	143,705
Blyth	8,496	11,806
The Hartlepools	163,685	128,898
The Humber	36,670	34,845
The West Coast	26,770	41,500
Belfast	149,238	143,477
Total	1,909,185	1,741,065

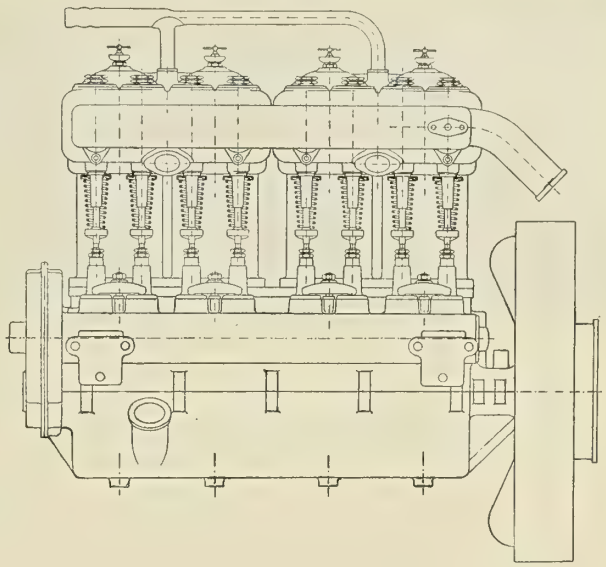
Progress of Naval Vessels.

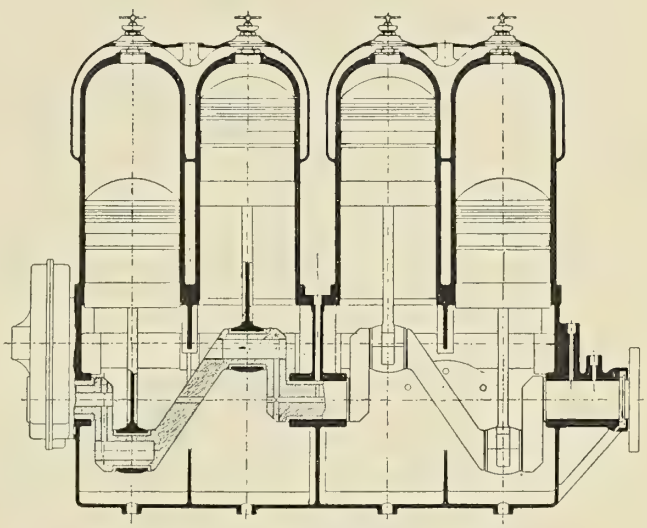
The Bureau of Construction and Repair, Navy Department, reports under date of December 10, 1906, the following percentage of completion of vessels building for the United States Navy:

			Nov. 1	Dec. 1
BATTLESHIPS.				
Nebraska	19 knots.	Moran Brothers Co.	97.	97.5
Vermont	18 "	Fore River Shipbuilding Co.	95.	96.
Kansas	18 "	New York Shipbuilding Co.	93.1	95.2
Minnesota	18 "	Newport News Co.	97.	98.
Mississippi	17 "	Wm. Cramp & Sons.	67.82	69.6
Idaho	17 "	Wm. Cramp & Sons.	64.03	65.15
New Hampshire	18 "	New York Shipbuilding Co.	54.3	57.
Michigan	19 "	New York Shipbuilding Co.	0.85	1.51
South Carolina	19 "	Wm. Cramp & Sons.	0.6	3.14
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works.	96.1	97.
South Dakota	22 "	Union Iron Works.	93.4	93.5
North Carolina	22 "	Newport News Co.	63.28	66.35
Montana	22 "	Newport News Co.	56.84	60.62
SEMI-ARMORED CRUISER.				
Milwaukee	22 knots.	Union Iron Works.	99.4	99.9
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works.	51.9	54.83
Birmingham	24 "	Fore River Shipbuilding Co.	50.7	52.7
Salem	24 "	Fore River Shipbuilding Co.	50.7	52.7
SUBMARINE TORPEDO BOATS.				
Cuttlefish		Fore River Shipbuilding Co.	90.	90.
Viper		Fore River Shipbuilding Co.	81.5	82.72
Tarantula		Fore River Shipbuilding Co.	92.	92.
Octopus		Fore River Shipbuilding Co.	78.8	81.1

A New Italian High Speed Motor Boat.

The illustration and drawing show the details of construction of a new Italian engine utilized for high speed motor boat service and automobiles, and one of the boats under full speed. It





THE ENGINE OF THE MOTOR BOAT ZUEST.

was constructed at Milan, Italy, by the Fabbrica Italiana di Automobili Ing. Roberto Züst. The engine is constructed with four cylinders, and has a capacity of 50 horsepower. For automobile service the engine is constructed also of 28 horsepower capacity. The ignition utilized with these engines, both for the autoboat and the automobile, is that of the Siemme-Bosch magneto system. Nickel steel is employed extensively, and these engines and motor boats are well known throughout Italy as of the most up-to-date models, and very satisfactory in operation.

THE MOTOR BOAT ZUEST AT FULL SPEED ON THE MEDITERRANEAN.

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

The edition of this issue comprises 6,000 copies. We have no free list, accept no return copies and issue only enough to supply the regular demand.

Healthy Types of Motor Boats.

Announcement of the projected motor boat race between New York and Bermuda, a distance of some seven hundred miles across a notably rough portion of the North Atlantic ocean, has been followed by the publication of designs for a number of vessels intended to compete for the trophy offered. The regulations imposed by the Joint Committee from the two yacht clubs concerned with the race have made it necessary for these designs to give full effect to all the seaworthiness possible, and to avoid all semblance of freakishness or of the machine type of racing boat.

As a result, it may be expected that all the boats entered will be of such a character as to be able to meet successfully all ordinary storms at sea, and to make headway under circumstances such as would prove absolutely deterrent to any less robust type of small boat. This is a long step in the right direction, and one which will doubtless ultimately redound to the benefit of builders of this type of craft, not only in the United States but in Europe.

Little has been gained by the development of racing freaks, except possibly some improvements in the character of materials used in the construction of boats and engines. The general science, however, has made little advance in connection with these launches, but much may be expected from the limitations imposed upon the present class of vessels.

Changes in Steamship Lines.

Much interest has been manifested in the fact that the White Star and Cunard Lines have announced a change in their English terminus. Heretofore both of these lines have run all of their ships plying between New York and Great Britain to Liverpool, the Cunard steamers making an intermediate stop at Queenstown. It has just been announced, however, that in order to facilitate rapid transportation of passengers and mails to London, Southampton has been selected by both companies as the terminus for a number of important ships.

The first announcement of this character was made by the White Star Line, which operates steamers from New York on Wednesdays and Fridays, to the effect that the Friday service would hereafter be superseded by a series of steamers sailing on Thursday; while the Wednesday service would, as soon as the *Adriatic* is completed, be directed to Southampton instead of Liverpool, and would be maintained by the *Adriatic, Oceanic, Teutonic* and *Majestic*. This new service is to be known as the United States and Royal Mail, and will be inaugurated in May. Going east, the steamers will call at Plymouth and Cherbourg, the mails being landed at Plymouth, while passengers will have the option of disembarking at any one of the three ports. West bound steamers will call at Cherbourg and Queenstown for passengers and mail, before proceeding across the Atlantic.

In making this change the company has been influenced by the convenience of the channel ports for reaching both Paris and London. The White Star Line will be the first flying the British flag to call at these channel ports. Of the main lines of steamships from New York to Great Britain and the north of Europe, the only one having its terminal in the south of England is the American Line. Steamers of the Hamburg-American and North German Lloyd Lines call at channel ports, but both have terminals in Germany.

Almost immediately after this announcement was made, came another from the Cunard Company to the effect that the two new express steamers *Lusitania* and *Mauretania* will make their English terminus at Southampton, as will be the case with the White Star Line and American Line. These steamers will touch at Queenstown in both directions, this port being somewhat out of the direct route. The high speed of the steamers, however, is expected to minimize the delay caused by the slightly longer trip, and the proximity of Southampton to London may be said to overcome all possible objections against the new route, except those emanating from purely local sources and influences. The Cunard Company will not give up its weekly service to Liverpool, which will be maintained, as at present, by the *Etruria, Campania, Caronia* and *Carmania*.

The new service will give fast ships on two days of the week to the south of England, instead of allowing

for only one service per week, as at present; and for this reason will much facilitate the transport of passengers and mails to the tourist ports on the Channel. Both companies have made arrangements with the London & Southwestern Railway for piers to accommodate the large vessels diverted to the new route, and it is expected that the constructions will be of such character and size as to accomodate at once all of the large vessels entering the port.

Derelicts.

During the month of January much apprehension has been felt regarding a steamer bound from Porto Rico to New York, but which, after being twelve days overdue, was towed into Bermuda with a broken shaft. This steamer had a route frequented by other vessels, but had not been reported by any of them for about two weeks. Many theories were rife as to the cause of her non-appearance, the most plausible of which was that she might have struck a derelict, and been so badly injured as to be ultimately totally lost.

The menace in question is usually a vessel carrying lumber or some other light cargo which would tend to buoy her up in spite of whatever water might enter her hold, and is particularly prevalent along the Atlantic coast of the United States. Some years ago a conference in Washington recommended united efforts by the various maritime powers for the sytematic removal of all vessels of this character, but little was done; and, although the United States Navy Department and the Treasury Department, under its Revenue Cutter Service, have done much, there still remain large numbers of these floating terrors, and not infrequently are they reported as having been narrowly missed by vessels.

A new revenue cutter is under process of design at Washington, whose main duty it shall be to seek and destroy derelicts upon the Atlantic coast. This will fill a long-felt need, and will render more safe the paths of ocean commerce, particularly those in the vicinity of Cape Hatteras, where many of these craft have been abandoned by virtue of stress of weather. This vessel will be provided with all necessary appliances for disrupting these vessels by means of dynamite or gun cotton, and will be continually employed in this service.

British Naval Maneuvers.

It has been announced that the British navy is in February to carry on maneuvers off the Portuguese coast with a fleet comprising thirty first class battleships, sixteen armored cruisers and fourteen protected cruisers, the aggregate displacement of these sixty vessels being 681,725 tons. This is by far the largest fleet ever assembled for any purpose whatever, and has been made up without drawing upon the reserve squadrons. It exceeds the present combined battleship strength of France and Germany.

Of the thirty battleships, seven are of over 16,000 tons each, and only six are under 14,000 tons. All but three of the armored cruisers displace more than 10,000 tons each. The average displacement of the battleships is 14,645 tons; of the armored cruisers, 11,626 tons; of the protected cruisers, 4,025 tons; of the entire fleet, 11,362 tons.

The value of such maneuvers is very great, inasmuch as they form the only available means whereby officers and men can become familiar with the handling under war conditions of the great forces entrusted to their care. Strictly bellicose regulations are maintained in all cases, and the discipline is as strict as if war were actually a fact. Vigilance, ingenuity and activity are at a premium, every man connected with the operations being kept on the alert; and the results, as determined by the verdicts of competent judges upon the fleets, go far to make up the science of naval strategy.

The Warrant Machinist.

The first editorial on page 38 of our January number has excited considerable comment, and in some quarters the impression seems to prevail that the tone of our comment is decidedly derogatory to the warrant machinist. It is unfortunate that this impression should exist, as it was furthest from our thoughts when penning the article in question. The warrant machinist has practically absolute charge of machinery in the United States navy, and we have long been of the opinion, and have not hesitated about expressing it, that he should be given authority and opportunities commensurate with the responsibility which he is called upon to assume. Up to the present time this sort of recognition is entirely lacking, and ambitious men of great talent along these particular lines have naturally hesitated about entering a service in which the future holds out so little inducement.

We have long contended that for the elevation of the engineering service on men-of-war to a position such as its importance deserves, it would be necessary to so arrange matters as to bring into responsible positions on board these vessels officers whose experience in the handling of machinery was supplemented by a broad understanding of the basic principles upon which all machinery operates, and of the more theoretical considerations entering into the design and operation of such devices as are found necessary upon men-of-war. Graduates of Annapolis, or of other good technical colleges, have the requisite theoretical training for the positions in view, but without such experience as is represented by that now possessed by members of the corps of warrant machinists this theoretical knowledge is of little practical value. It is by a combination of the two that the best results may be achieved, and this combination can exist only when men of high training can be induced to enter the service, and get the practical side at first hand. This condition will exist only when these men are assured of promotion to commissioned rank so soon as their attainments and the condition of the service warrant this advancement.

The 1907 Motor Boat Show.

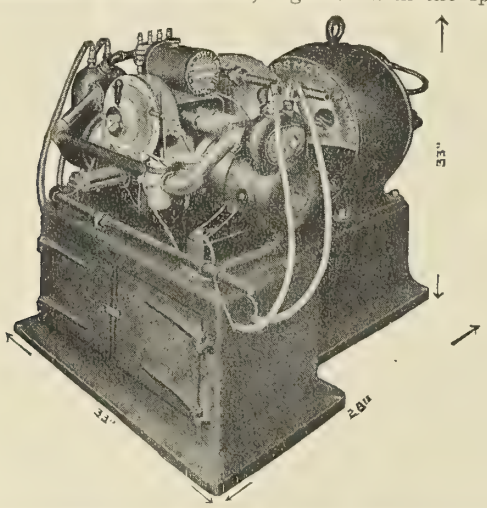
The attention of engine and boat builders and manufacturers of all kinds of accessories is called to the 1907 National Motor Boat Show, to be held under the auspices of the National Association of Engine and Boat Manufacturers at Madison Square Garden, New York, February 19 to 26, inclusive, as being the only national show of the engine and boat building industry of this country. This will be the first show of a national character ever held that will be an out-and-out engine and boat show. The space of time that this show will be open is only eight days, whereas, heretofore, the national show has been held in connection with the Sportsman's Show, and was of fifteen days' duration. This long period has necessitated a loss of considerable time to both employers and employees from their respective plants, which has added greatly to the cost of exhibits. With the show now a distinct engine and boat show, and of but eight days' duration, considerable expense is saved the respective exhibitors.

The Export World.—A new monthly is being issued by E. J. P. Benn, Christopher street, Finsbury Square, London, E. C., the object being the scientific promotion of the continual increase of British trade in all the markets of the world. The new paper will appear monthly from January, 1907, and undertakes not only the dissemination of news regarding markets, tariffs, rates and trade openings and other matters in export and import lines, but also the translation of such items as may come in to the various advertisers in response to their notices. The reference portions of each issue will be printed in English, French, German and Spanish, and advertisements will be published in any of these languages, as desired. It is the aim of the paper to be world-wide in scope, and to fill a need along this particular line.

ENGINEERING SPECIALTIES

The Phillips Marine Generating Plant.

We illustrate the Phillips duplex governed motor, as direct connected to a dynamo. The capacity of this gaso-electro unit is seventy-five 16-candlepower lamps at 110 volts, and it can be used economically as low as twenty lights. It occupies a space of 33 by 48 inches, by 33 inches high. The storage ignition battery is contained in the sub-base, together with the spark coils.



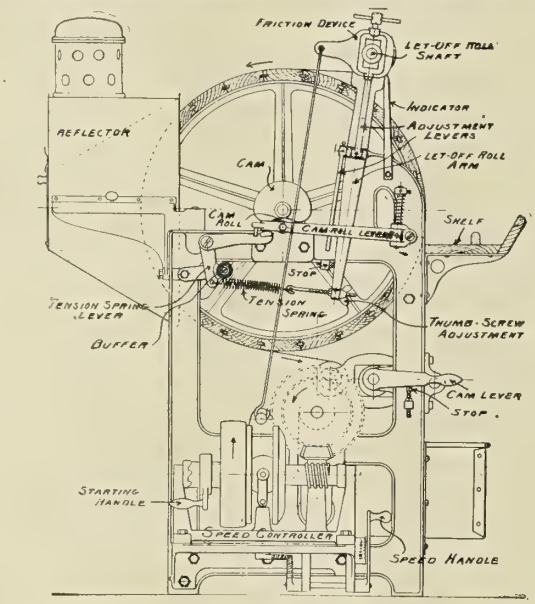
The outfit is furnished with either a water cooling tank or a circulating pump, or both. As the shipping weight is about 1,500 pounds, it is one of the most compact, complete, self-contained gasoline electric lighting plants that has yet been produced. The plant runs with so very little vibration that when placed on an ordinary good floor further foundation is said to be unnecessary. It is especially desirable for lighting purposes on a boat.

The Phillips duplex governed non-vibrating marine motor is practically the same as is used on the generating plant, but with a little different attachment for the regulation of the governor. Some of the claims made for this motor are its low center of gravity, its non-vibrating feature, and its duplex ignition and carbureting system, all of which tend to make the motor safe and sure in its action, and not liable to stoppages at inopportune times. These outfits are placed upon the market by the Phillips Gasoline Engine & Motor Works, 492 Tacoma Building, Chicago.

The Federal Blue Printing Machine.

Of late years there has been created, in offices where blue prints are required in large quantities, a demand for some means of rapid printing by artificial light. To meet this demand a number of machines have been placed upon the market.

Of these, one of the most successful is the Federal blue printing machine, which has many points of superiority and has given universally excellent satisfaction. It combines economy, quickness, convenience and durability, is practically automatic, and is so simple that it can be operated by a boy. It makes continuous prints by electric light nearly as fast as they can be made by the most favorable sunlight. There is no loss of time in preparing the apparatus for each separate exposure, and in removing the work after the copies are printed. There is no glass to break from uneven pressure, heat, sudden change in temperature or careless handling, none being used in the machine. There is for practical purposes no limit to the length of a print which may be exposed, and this fact will be found of advantage in the printing of very long railway profiles or ship's lines, which are otherwise



Side Elevation.
Federal Electric Blue Printing Mach.

printed in sections and pasted together. Finally, the use of this machine obviates the hard labor required in handling the larger and more cumbersome apparatus.

The machine comprises a large drum mounted in roller bearings; an apron for effecting smooth contact between the drawing and the blue print paper; a reflector containing the electric lamps; a small electric motor; a speed-controlling device and a device for regulating the tension upon the apron. The action is simple. Upon a small roll above the drum is wound a long strip of flexible transparent material, called the "apron." This passes around the drum, being in contact with it for about half the circumference, and then passes between two rubber pulling or drawing rolls placed underneath the drum. Perfect contact between the tracing and blue print paper is thus secured over the entire width of the drum. The speed of travel of the machine can be regulated to suit various tracings by means of a patent speed-controller, the change being made while the machine is running, by simply moving a lever to different notches on a sector.

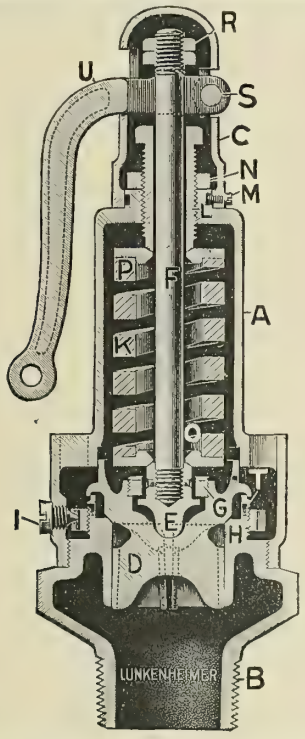
A small motor of ¼ horsepower is used, or a belt may be connected from an overhead shaft to the speed controller, if the

machine is placed in a room provided with power. The motor and lamps are supplied for either direct or alternating current. The machine is made in three sizes, to print up to 30, 42 and 54 inches wide, and having respectively 4, 6 and 8 lamps each. The height of the machine from floor to the top of the lamps is 4 feet 10 inches, its depth is 4 feet 6 inches, the width of the three sizes being respectively 4, 6 and 7 feet. The machine is manufactured and placed on the market by Keuffel & Esser Co., 127 Fulton street, New York.

An Improved Pop Safety Valve.

The Lunkenheimer Company, Cincinnati, Ohio, have lately redesigned their pop safety valve, and as now constructed the valve is said to fulfil in all respects the most rigid requirements. It is made of bronze composition, well finished, and has large springs, insuring great durability. It is simple in construction, and warranted to be reliable, accurate and positive in operation. With full relieving capacity, it is very sensitive to excessive pressure, and admits of being finely adjusted.

The valves are provided with lock-key attachment, to guard against being tampered with, and adjustments of pop lid and



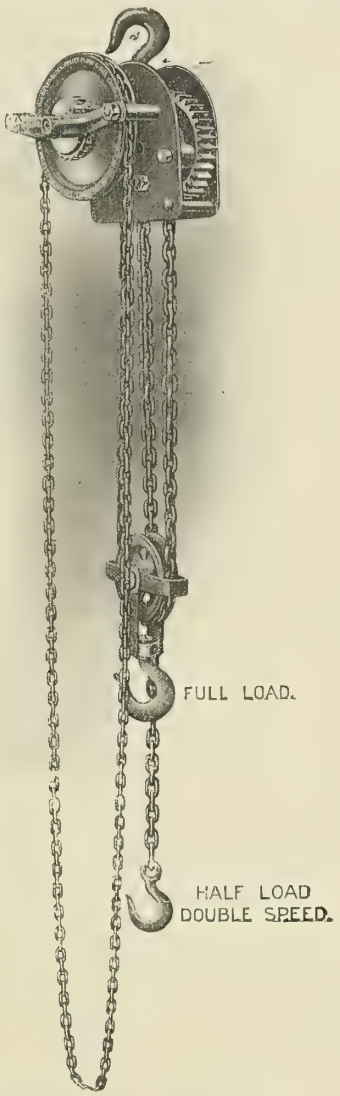
pressure can be made from the outside of the valve, without taking it apart. The springs rest between ball and socket plates, which equally divides the pressure on the disk, and are encased, hence the valve cannot be affected by back pressure. They have bevel seats, at an angle of 45 degrees to the vertical axis of the valve; are provided with suitable levers, by means of which the disks can be raised from their seats; and are allowed one square inch of valve area to every three square feet of grate surface of boilers.

To take the valve apart, the lever *U* is removed, then the bonnet *C*, after which the load on the spring is relieved by unscrewing the regulating screw *L*. The regulating ring screw *I* is then removed, and the bell *A* unscrewed. To set the valve for a higher pressure, it is only necessary to turn the regulating screw *L* down, and for a lower pressure, to turn it up.

The pop or action of the escaping steam is regulated by the ring *H*, in the base of the valve, which is easily accessible without taking the valve apart, and is held securely in place when set by the regulating ring screw *I* on the side of the bell. If the valve pops suddenly, and does not relieve the pressure enough, the ring *H* is turned up, which covers the drill holes and causes the disk to remain longer off its seat. If the valve pops too much, opening and closing gradually, then the ring *H* is turned down. When the desired adjustment is obtained, the ring is secured by means of the screw *I*.

The Axallwazo Chain Block.

Rowland Priest, of Lomey Town, Cradley Heath, England, has placed upon the market a spur gear differential hoist fitted for two speeds, and so arranged that a double chain is used for lifting the full load, while a single chain lifts loads up to half the capacity of the block at double the full load speed. This arrangement renders the block especially handy. The efficiency is said to be very high, particularly when compared with worm gear blocks,



while the lowering of loads is said to be under absolutely perfect control. The block is built in seven different sizes, the maximum capacities being respectively ½, 1, 1½, 2, 3, 4 and 5 tons. In each case the block is tested by dead weight to 50 percent more than rated load. The approximate weight of the block complete, with chains for a 10-foot lift, is 70 pounds for the smallest, and 294 pounds for the largest capacity.

TECHNICAL PUBLICATIONS.

Neuere Schiffsmaschinen. By H. Rosenthal, M. Müller and R. Bayer. Size, 8 by 10¾ inches. Plates, 53. Berlin, 1906. Konrad W. Mecklenburg.

This book consists entirely of plates, measuring 10¾ by 15½ inches, with a total of more than 1,200 drawings of the various parts of the machinery used on board warships and merchant vessels. The first section includes eight plates on boilers and their details. The next five plates cover auxiliaries for the boilers and boiler room, including steam pipes, ash ejectors, feed

water heaters, etc. After this come seven plates dealing with indicator and valve diagrams. The next seven plates deal with the general arrangement of the cylinders in marine engines. The next seven take up details of marine engines, including pistons, cylinders, stuffing boxes, framing, connecting rods, crank shafts and bearings. One plate is devoted to screw propellers and their development. The next four plates cover pumps of various kinds. The next three deal with pipe plans, ventilation, engine room telegraphs, etc. The next three illustrate steering machinery. After this come winches, capstans, cranes, distilling apparatus, ice machinery, and lastly, steam turbines.

The work is gotten up with characteristic German thoroughness, and includes a vast amount of detail under all of the headings mentioned. There is no text accompanying it, but, as a matter of fact, a text would be unnecessary to a student of the subject, or to anyone familiar with the apparatus described. Most of the items given are anonymous so far as application to any given ship is concerned, but in a few cases direct reference is made to the ship from which the details were taken.

Record of American and Foreign Shipping. Size, 8 by 9½ inches. Pages, 1,198. American Bureau of Shipping, 66 Beaver street, New York. Price, $15.00.

The volume for 1907 of the "Record of American and Foreign Shipping" (American Lloyd's), which is the thirty-ninth annual issue of this register, is now being delivered to subscribers.

The Record contains full reports and particulars of 12,527 vessels, ranging from the ketch to the full powered transatlantic liner, and flying the flag of every nation, alphabetically arranged, with much detail as to build, ownership and condition. This information forms the bulk of the annual volume, but it also contains rules for the construction and classification of all classes of vessels, with illustrations and tables of great technical and practical value; revised rules for the construction of machinery and boilers, electric installations and refrigerating apparatus on shipboard.

The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name, for ready reference; list of addresses of prominent shipbuilders, dry-docks and marine railways of the United States; list of owners of vessels, all of much value to the shipping interests. The work is approved and indorsed by the important boards of underwriters of the United States, and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume, issued semi-monthly, keep subscribers informed of new vessels, constructed during the year, with reports of repairs to old vessels, and other useful information.

Switchboards. By William Baxter, Jr. Size, 5½ by 8 inches. Pages, 192; figures, 150. New York, 1906. The Derry-Collard Company. Price, $1.50.

The book covers switchboards for power, light and railway service; for direct and alternating current; for high and low tension. It is thoroughly well illustrated with a profusion of drawings and half tone engravings from photographs, covering all varieties of switchboard instruments and fittings in general, and includes in the alternating current department boards for single phase, two-phase and three-phase currents, as well as arrangements for numerous devices such as synchroscopes, ground detectors, lighting arresters, oil break switches, etc.

A second portion of the work deals with switches, and covers the subject in much detail, with illustrations both line and half tone, and showing all of the usual types, as well as oil break switches and those operated by power. Circuit breakers form a section under this heading, while some attention is given to lightning arresters and non-arcing metals.

The Slide Rule: A Practical Manual. By C. N. Pickworth. Size, 5 by 7 inches. Pages, 105; figures, 24. New York. D. Van Nostrand Company, 1906. Price, $1.00.

This is the tenth edition of what is said to have been the first English work on the modern slide rule, and has been substantially revised, as compared with some of the earlier editions. The author recognizes that while a useful knowledge of the slide rule may be obtained by actually using it, an acquaintance with the rudiments of logarithmic computation is necessary to enable the operator to take that intelligent interest in the manipulation of the rule, which is indispensable if confidence in its results and ability to extend its application are required.

After taking up the mechanical principles of the addition of distances made proportional to the logarithms of their several numbers, the author gives directions for carrying through operations on the ordinary 10-inch slide rule, and thus goes into multiplication and division. Involution and evolution receive adequate treatment, with examples to illustrate the use of the rule. With these are given examples in technical computations, showing the application of the rule to useful purposes.

In the rear of the book are given descriptions of various special rules for performing functions different from those required of the ordinary rule, as well as special types of rules for performing those same functions. A circular calculator, shaped like a watch, may be mentioned under the latter heading, while spiral rules of the Fuller and other types are given consideration, as being of much greater accuracy than it is possible to attain with the simpler instruments.

The Marine Steam Turbine. By J. W. Sothern. Size, 5½ by 8½ inches. Pages, 163; figures, 77. London, 1906. Whittaker & Company. Price, sixpence, net.

This is the second edition of a work prepared by the author in response to a demand for practical information upon the latest developments along this particular line, and deals entirely with the Parsons type of turbine. It starts out in a very elementary way, with definitions of units used in steam engineering and mechanics generally, and explains the expansion of steam and its effect in the production of power.

The various details of design and construction are taken up in order, attention being given to such subjects as clearances, blading, packing, heat expansion, propeller dimensions, slip and cavitation, efficiencies of turbine and propellers, and steam and coal consumption. Figures are compiled from various sources, giving comparisons between turbines and reciprocating engines, particularly along the line of coal and steam consumption of similar ships at corresponding speeds.

The work seems to be thoroughly practical in all its details, is profusely illustrated with both half tones and line engravings, and gives a great deal of data from the actual operation of ships propelled by turbines. The last chapter covers the torsion meter patented by Messrs. Denny & Johnson, and is followed by elementary problems in marine turbine design, with answers.

The Marine Steam Turbine. By Professor J. H. Biles, LL. D., of Glasgow University. Size, 5¼ by 7⅝ inches. Pages, 126; figures, 131. Philadelphia, 1907. J. B. Lippincott Company. Price, $2.00, net.

The first part of the work, which represents a series of lectures delivered before the Royal Scottish Society of Arts early in 1906, is taken up with descriptions and illustrations of the earliest types of prime movers, particularly those operating upon the rotary principle. The development is carried on to the latest types of these engines, and comparisons are instituted between rotary and reciprocating machinery. The second and third chapters describe in some detail the construction and blading of marine turbines, and deal with the action of steam in the turbine, and the determination of proper dimensions. The fourth chapter takes up the action of screw propellers in turbine vessels, with a good many curves showing the variation of efficiency with varying pitch ratios, etc., and reproduces results of many experiments upon propellers in model form. The fifth and last chapter deals with the combination of the turbine and the propeller, and gives a good deal of information regarding a number of turbine vessels, and comparisons between turbines and piston engines.

The illustrations are well chosen, but are in general unduly small. They include both half tones and line cuts, the former covering every type of turbine-propelled vessel, and including the most important instances of such ships. A great many illustrations are given in connection with the building of the turbine, showing the assembling of the parts of the rotor, and showing also in some detail the blading of both rotors and stators.

Self-Propelled Vehicles: A Practical Treatise on the Theory, Construction, Operation, Care and Management of all Forms of Automobiles. By James E. Homans, A. M. Size, 5⅜ by 8⅛ inches. Pages, 598; figures, 399 + 4 folding plates. New York, 1907. Theo. Audel & Company. Price, $2.00, net.

This is the fifth edition of the work, which has been completely revised and brought up to date. Theoretical matters, which are important to designers and builders, are introduced only where absolutely necessary, and in no case is experimental or obsolete material brought in.

Recognizing the fact that the gasoline vehicle is typical of automobile practice, most of the space has been devoted to this type of car, and an extensive chapter is given on gasoline engine management. All the accessory parts of an automobile, including carburetors, igniters, transmission gear, etc., are fully explained by typical examples.

Electric vehicles, as well as those operated by steam, are given adequate attention, while at the end of the work are chapters on the construction and operation of brakes, ball and roller bearings and lubricators. These are followed by a complete index, covering sixteen pages, and rendering the work extremely handy for reference. The illustrations cover every phase of the subject, and the work will doubtless prove of great interest to all who have to deal with automobiles.

Les Flottes de Combat en 1907. By Commandant de Balincourt. Size, 6 by 4½ inches. Pages, 776; illustrations, 359. Paris, 1907. Berger-Levrault & Company. Price, 6 francs.

This is the sixth annual edition of the work, and is of especial interest by virtue of the information contained on the very latest war vessels projected or laid down. Each type of ship is illustrated on a left-hand page, while on the right-hand page facing it is a description of the vessel, her machinery, battery and protection.

Particularly interesting in the present number are the illustrations of the latest battleships for the German, English, American, French and Japanese navies, together with the descriptions accompanying these views. The illustrations do not pretend to be accurate, so far as scale is concerned, but they give a good idea as to the general appearance of each vessel, and show the disposition of battery and armor.

More than one thousand ships are included in the descriptions, while the torpedo craft are even more numerous.

Electrical Wiring and Construction Tables. By Henry C. Horstmann and Victor H. Tousley. Size, 4¼ by 6 inches. Pages, 119; figures, 24. Chicago, 1907. Frederick J. Drake & Company. Price, in flexible leather covers, $1.50, net.

This little book is primarily intended for a pocket hand book. In order to economize space much of the matter which is usually included in such hand books, such as tables of logarithms, tangents and other mathematical material, have been omitted. The object has been rather to provide a practical book, giving in as complete and concise a manner as possible such information as is constantly needed by the wireman, foreman, contractor, engineer and architect, and without which tedious calculations would have to be made.

The work is divided into seven chapters, covering respectively direct current wiring tables; alternating current wiring tables; economy of conductors; miscellaneous, including electric illumination, combined carrying capacities, etc., measurements and formulas; calculation of materials; conduits and wires; and tables of carrying capacities. All parts are so simply handled as to be very readily understood.

Motor Boats. By Professor William F. Durand. Size, 6 by 8⅝ inches. Pages, 209; figures, 81. New York, 1907. International Marine Engineering. Price, $1.50.

This little book on boats propelled by internal combustion engines, and covering also descriptions of the engines themselves, has been reprinted from the columns of this magazine, and covers in much detail the entire subject comprised within the title. It starts out by stating the general problem to be met, and then proceeds with a description of the principles of operation of the gas engine, following this up with views of engines of various types and sizes, and descriptions of their characteristics. Then the boat itself is taken up, with instructions for the laying down of the lines, and the general arrangement of the hull, giving particulars of both the above water form and that below the surface; and practical boat construction, including the laying down of the material and assembling of the parts, is given careful attention.

The subject of power and speed is next taken up, the relation between characteristics of the form of hull and the resistance to be met at various speeds being shown, and a number of examples worked out to illustrate the principles involved. After this, some attention is given to propeller design, with examples showing the way in which this feature of the problem is taken care of. After this come a number of chapters on such subjects as endurance, stability and the reaction of the propeller. Troubles and their remedies are given careful attention, and the last part of the main section of the book takes up the allied subjects of racing rules and time allowance.

An appendix is given, in two parts, the first of which treats of alcohol as a fuel for gas engines, while the second takes up the use of kerosene oil in engines built for gasoline.

The entire work is thoroughly up to date, and practical in its character, and can be heartily recommended to the attention of any one interested in this very live topic.

Boiler Waters. By William W. Christie. Size, 6 by 9 inches. Pages, 235 + 73; illustrations, 77. New York, 1906. D. Van Nostrand Company. Price, $3.00, net.

The work starts out with the proposition that a steam boiler is a steam generator, and not a kettle for chemical reaction. The object of the work is to furnish steam users with information regarding water, its use and the troubles arising from its use, together with remedies looking to a gain from a more efficient generation of steam.

The subject is taken up in ten chapters, dealing with the properties and analysis of water; the transmission of heat through such solids as are represented by boiler scale; corrosion; tubes and pipes used in boilers; priming and foaming; oil and grease and the use of zinc; the hardness of water; water softening; feed water heaters and economizers; and lastly, miscellaneous tables, including factors of evaporation, properties of saturated steam and the weight and expansion of water at various temperatures.

The illustrations include both half tones and line cuts, of various systems in operation for the softening and purification of water, both American and European devices being illustrated and described.

Obituary.

Commander Albert B. Canaga, U. S. N., died suddenly December 24, 1906. Commander Canaga was graduated from the Naval Academy in 1874, and had sea duty on various ships in all parts of the world. During the Spanish war he was in the Bureau of Steam Engineering, after which he was transferred to the Cavité naval station, and for the past six months was engineering officer of the Boston navy yard.

J. Augustin Normand, naval constructor and engineer, died recently at Havre, France. He began his professional career in 1860 as an employee of a shipbuilding firm, of which his father was the chief. In 1871 the son became the head of the firm, a position he held until his death. Mr. Normand's name is best

known in connection with the design of high-speed steam craft, a line in which he was a pioneer. The torpedo boats which he built for the French government proved very fast, and showed some novel and valuable features of design.

Personals.

A number of changes in the office of the passenger traffic manager of the steamship lines operated by Mr. C. W. Morse may be summarized as follows:

Charles C. Brown becomes general passenger agent, with temporary headquarters at Pier 32, North river, New York.

A. H. Hanscom resigns from the office of general passenger and ticket agent of the Eastern Steamship Company, to become assistant to the president, Calvin Austin.

J. H. Allaire and R. L. Hornby, general passenger agents respectively of the People's Line and the Troy Line, have resigned to accept other service with the company.

Asa M. Mattice has discontinued his business of consulting engineer, to take the works management of the Walworth Manufacturing Company, South Boston, Mass.

The firm of Messrs. G. Pitre & Company, Maisons-Lafitte, France, has been succeeded by Messrs. G. de Coninck & Company, who will continue the business of building boats of all kinds, including sailing and steam yachts of wood and steel, small merchant steamers, etc.

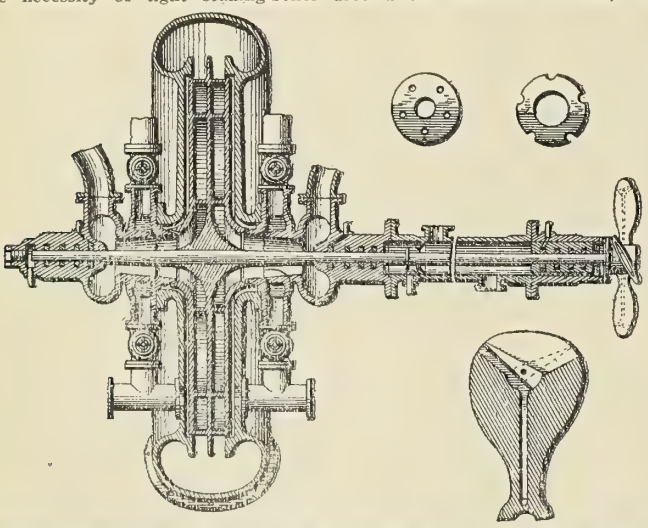
J. E. Lawler & Muirhead, 39 Lime street, E. C., have been appointed London representative of the Hunslet Engine Works, of Leeds, England.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

833,591. MARINE ENGINE. HENRY A. DUC, JR., CHARLESTON, S. C.

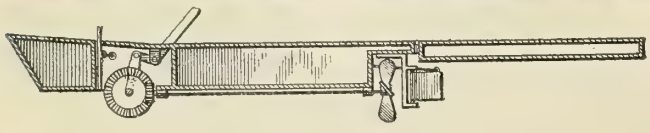
Abstract.—This invention is an improvement in elastic-fluid turbine-engines of the marine type, and involves a novel construction of the turbine-engine and of the propeller operated thereby, which latter is utilized to maintain a partial vacuum around the shaft-journals, so that the necessity of tight stuffing-boxes around the shaft is obviated, with



resultant lessening of friction upon the shaft, and the propeller may also be utilized to reduce the skin friction on the operative parts of the engine by partially exhausting the chambers in which the moving parts operate. The propeller may also be utilized to produce a circulation of water or other fluid medium around the shaft and bearings. Fourteen claims.

833,608. LIFE-SAVING APPARATUS. JOSEPH LE BLANC, WELLS, MICH.

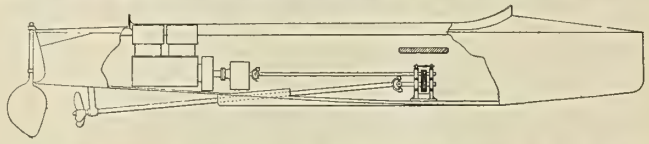
Abstract.—This invention relates to life-saving apparatus, the object



being to provide a simple, reliable, and practically non-capsizable float resembling a shallow boat or raft, consisting of fore and aft sections having a jointed and folding connection with each other, and each embodying water-tight compartments, the apparatus also embodying manually-actuated propelling means whereby the occupant of the float may propel the same through the water, also means whereby the float or raft may be steered. Three claims.

833,769. DRIVING-GEAR OF MOTOR-BOATS. HENRI C. BRASIER, IVRY-PORT, FRANCE.

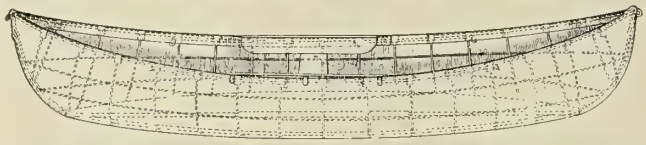
Claim.—1. A driving-gear for boats, comprising a motor located at the stern, a driving-shaft extending forwardly from said motor in a horizontal plane, a propeller located forwardly of the stern and below the



keel of the boat, a propeller-shaft inclined with respect to the motor-shaft and extending from the propeller through the bottom of the hull and forwardly therein to a point adjacent the front end of said motor-shaft, conical pinions for said motor and propeller-shafts, and bearings for said shafts spaced apart from said pinions to permit the employment of pinions of different size to vary the speed of said propeller. Four claims.

833,846. FOLDING OR COLLAPSIBLE BOAT. IRA O. PERRING, KALAMAZOO, MICH., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO LIFE-SAVING FOLDING CANVAS BOAT COMPANY, KALAMAZOO, A CORPORATION.

Claim.—6. In a folding boat, the combination of a suitable flexible skin; a bottom consisting of a body of canvas or like material, having cross-rods secured thereto; a keel detachably secured to said bottom;



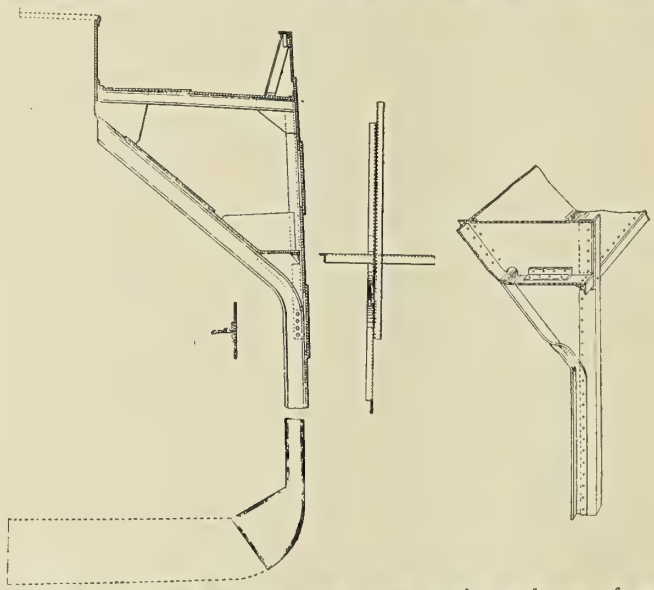
keel extensions; a gunwale made up of end sections and central sections, said end sections being secured to said keel extensions; brackets having horizontal and vertical sockets therein, sleeved upon said end sections of said gunwale, said horizontal sockets being adapted to receive the said central sections of said gunwale; and cross-ribs secured to the said bottom adapted to be inserted into the vertical sockets of said brackets. Twenty-three claims.

833,850. PROPELLER-WHEEL. NORMAN R. SMITH, SEATTLE, WASH.

Claim.—1. A propeller-wheel having blades extending through a material portion of its pitch length, the outer portion of one side face of the blades being concavely curved throughout the greater portion of its length, said surface at one end of the wheel reversing to a convex curve. Eight claims.

834,127. SHIP CONSTRUCTION. GEORGE M. HARROWAY AND WAYNMAN DIXON, MIDDLESBROUGH, ENGLAND.

Claim.—1. In a ship construction, main framing comprising cantilever-frames in each of which there are a lower portion and two branches extending upwardly from said lower portion, namely a continuous outer branch to which the skin of the ship is riveted and which has an inwardly projecting flange formed with a gap and a branch inclining inwardly



toward the middle of the ship, said lower portion and one of said branches being constituted by a main bar, and the other of said branches being formed by a separate bar rigidly riveted to said lower portion so as to constitute an integral portion of the cantilever-frame, a longitudinal stringer riveted to the shell and extending through said gaps, fore-and-aft plating riveted to said inwardly-inclining branches and at its bottom portion to said stringer, deck-plating connecting said fore-and-aft plating to said shell and transverse stiffeners between said branches of each cantilever-frame, said fore-and-aft plating, said deck plating, the portion of the shell attached to the outer branches of the cantilever-frames, and said stiffeners constituting a water-tight longitudinal box-girder. Seven claims.